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ABSTRACT

The Pacific Telecommunications Council's 18th annual conference is presented in two volumes. The PTC'96 gathering focused on seven streams: socio-economic issues; regulatory, legal and political issues; business and finance solutions; country studies; education, training, and human resources; convergence and networks; and technologies and standards. The 130 papers are organized chronologically, according to date of presentation. The first volume comprises the papers presented on Monday, January 15, 1996. Topics covered in this volume include: telephony and cable television; converging technologies; interactive multimedia services; wireless technology; business networks; library networks; virtual academic libraries; mobile satellite services; international wireless telecommunications; competition and universal service policies; ownership; privatization; personal communications satellites; digital satellite modems; global information infrastructures; voice mail service in advanced intelligent network; network management; network planning; undersea cable industry; fiberoptics; strategic learning alliances; mobile satellite services; regulations; telecommunications delivery for rural populations; switching systems; electronic commerce; scrambling; national information infrastructure; data warehousing; and customer loyalty. Topics in the second volume, comprising papers presented on Tuesday, January 15 and Wednesday, January 17, 1996, include: business opportunities on the Internet; Internet in developing countries; convergent telecommunications; designing satellites; satellite services; regulations developing competition; telemedicine; network construction; televideo; relational database management systems; broadband services; Asynchronous Transmission (ATM); cellular telephones; interactive advertising; videoconferencing; software opportunities; intelligent agents; collaboration in emergency management communications; submarine cable; and financing the global information infrastructure. (Includes subject index). (AEF)

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18th Annual

edings

Edited by
Dan J. Wedemeyer and Richard Nickelson

14–18 January 1996
Sheraton Waikiki Hotel
Honolulu, Hawaii

PTC'96

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Proceedings

Volume I

Edited by
Dan J. Wedemeyer and Richard Nickelson

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Foreword

The Pacific Telecommunications Council's eighteenth annual conference, PTC'96, is now a two-volume reality.

Over the past years, PTC has organized a rich social-informational environment which has greatly facilitated knowledge building and networking of academic, business and governmental participants. This year's foci are manifest in seven streams: Socio-economic issues; regulatory, legal and political issues; business and finance solutions; country studies; education, training and human resources; convergence and networks; and, technologies and standards.

The quality of the papers in this volume, in the editors' assessments, has never been equalled. The"blind" review process (no names are associated with any submission) started with more than 330 proposed papers and resulted in the selection of 130. Each has been assigned to an appropriate session in a manner that will hopefully minimize conflicts for participants in covering their selected topics.

PTC'96, *The Information Infrastructure: Users, Resources and Strategies*, is organized in two volumes. **Volume One of the proceedings contains the papers presented on Monday of the conference. Volume Two contains the Tuesday and Wednesday papers.** As in the past, each volume has an index of subjects and a country/regional index. Once you have identified the paper you want to access, go to the table of contents, locate the paper, and refer to the page number. While it is appreciated that this two-step process is cumbersome, it is necessary in order to meet the tight "turn around" time between receiving the submissions and having the printed proceedings available at the conference.

For the past eighteen years the Pacific Telecommunication Council has organized a conference which has attracted many of the leading telecommunication professionals in the world. In order to do one's "homework" in this rapidly growing and changing environment, attending the annual PTC conference is now seen as essential. Events of such quality have at least a one-and-one-half year planning process. Successful conferences most definitely require dedicated volunteer work and first-rate PTC administrative and staff support in order to facilitate distinguished participants' contributions. The past conference successes speak well for a high quality and dedicated group of people. Finally, the support for the printing of the PTC'96 conference proceedings comes from AT&T Submarine Systems, Inc. Their contribution is most appreciated.

Now, on behalf of the PTC conference committee we want to extend a warm welcome to you. From the quality of the conference program and the quality of the papers in these volumes, PTC'96 promises to expand the reputation of a first-rate conference.

Aloha,

Dan J. Wedemeyer
Richard Nickelson
Honolulu, 1996

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PTC'96 is organized by the Pacific Telecommunications Council, an international non-governmental, non-profit organization. The council is regional in nature, embracing members from all the countries that play a role in the development of Pacific telecommunications. Its 500 members from industry, academia and government are dedicated to promoting the understanding and beneficial use of telecommunications throughout the entire Pacific Hemisphere--North, Central, and South America, East, South and Southeast Asia, Australia, New Zealand, Melanesia, Micronesia and Polynesia.

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TABLE OF CONTENTS

Subject Index
Country and Region Index

Monday, 15 January 1996

1 M.1.1.1 CATV-Telephony Convergence in Asia
Alexandra Rehak, Achmad Chadran

8 M.1.1.2 Converging Technologies: Towards Enterprise Integration
Dušan P. Jokanovic, Norio Shiratori, Kyosuke Moizumi

16 M.1.1.3 The Development of Interactive Multimedia Services (IMS)
Samantha Hon

21 M.1.1.4 MMDS: A Low-Cost Infrastructure for Video, Voice, and Data
Bruce Carruthers, Stephen Czarnecki, George Mandanis

26 M.1.2.1 Pacific Islands Business Network (PIBN): Marketing Oceania Overseas
James Di Giambattista

30 M.1.2.2 Libraries on the Information Superhighway: the Australian Experience
Carole A. Alcock

39 M.1.2.3 Multimedia and Asynchronous Learning: The Delivery of Education and Training Utilizing the Digital Library
Arthur S. Gloster II

46 M.1.3.1 The Impact of Wireless Local Loop Technologies in Asian-Pacific Markets
Andrew C. Simpson

54 M.1.3.2 Update on Mobile Satellite Services
Rex Hollis

59 M.1.3.3 Wireless in Indian Railway Telecommunication Network
Mohan Kishen Kaul, D. Swaminathan, B.A. Majmudar

62 M.1.3.4 Wireless Infrastructure in Vietnam: evaluating an emergent leapfrog strategy
A Lee Gilbert

71 M.1.4.1 The Impact of Local Competition on Universal Service Policies
Robert K. Yates, Johanne Lemay

78 M.1.4.2 Telecommunications in Transition: A Canadian Perspective on Ownership and Other Key Issues
Meriel V. M. Bradford

84 M.1.4.3 Intelsat Restructuring: How Can the Public Interest be Served?
Gregg Daffner

94 M.1.4.4 The Privatization of Intelsat: A User Perspective
Timothy S. Shea

100 M.1.5.1 Personal Communications Satellite Systems
Len J. Speltz

105 M.1.5.2 Advanced Modulation Techniques for Digital Satellite Modems
Henry Stewart, Rick Cannon

109 M.1.5.3 Transponder demand and supply in the Asia-Pacific region: How will they match over 1995-2005?
Stéphane Chenard

120 M.1.5.4 Roles of Satellite Communication in Global Information Infrastructure (GII)
Seon J. Chung

128 M.1.6.1 Enhancing Mexico's Information Infrastructure
Kathleen Ann Griffith

131 M.1.6.2 Palau Lightnet 2000 - A Telecommunications Revolution in an Emerging Nation
John J. Mariano, Karl E. Rye

139 M.1.6.3 The Information Infrastructure Meeting the Need of Bangladesh
Fazlur Rahman

144 M.1.6.4 Evolution of Information Networks and Future Trends in India
R.N. Bharadwaj, N.K. Srivatsava

152 M.1.7.1 Voice Mail Service in Advanced Intelligent Network
Kwang-Jae Jeong, Tae-Il Kim, Go-Bong Choi

159 M.1.7.2 Intelligent SS7 Network Management with S7DM
Jingsha He, Yi-Shang Shen, Don Albright

167 M.1.7.3 A Study on the DFP Architecture for Terminal Mobility: Design of the Terminal Access State Model
Ki Ryeung Kim, Tae Il Kim, Go Bong Choi

172 M.1.7.4 Open Programmable Switching: An Enabling Technology for Enhanced Services Deployment
Michael G. Hluchyj

177 M.2.1.2 Introducing Teledome Service - Making Effective Use of the Network Infrastructure in the Age of Multimedia
Naoki Takeda, Ryoji Tsukamoto, Tatsuya Ohtsubo

183 M.2.1.3 The Future Infrastructure for Commerce and Social Interaction - Ending the Tyranny of Distance, Place and Organisation
Robert G James

188 M.2.1.4 Efficient Broadcast File Transfer in a Satellite Communications Network
Gernot M. Engel, Dwight R. Bean

194 M.2.2.1 International Network Planning In a Changing Environment
Glenn L. Hunger, Arunabha Chatterjee

206 M.2.2.3 Strategic Network Challenges: The Case of Public Network Planning and Practice in Thailand
Robyn A. Lindley, Liaquat Hossain

213 M.2.2.4 End-to-End Multimedia Service Management Enabling Collaboration in a Distributed Enterprise Environment
Miyuki Sato, Kiyoh Nakamura, Sharad Kumar, David Liu, Rao Mikkilineni

220 M.2.3.1 A New Approach to Procurement Practices for the Undersea Cable Industry
Y. Niiro, S.W. Dawson, J. Roberts

225 M.2.3.2 FSA-10G Large Capacity Submarine Optical Amplifier System and Upgrade Trials for the Future
Masaki Amemiya, Yoshiaki Sato

233 M.2.3.3 Fiberoptic Link Around the Globe (FLAG) The FLAG Cable System Network
Robert E. Sullivan

238 M.2.3.4 Future submarine networks: the benefit of new technologies
P. M. Gabla

246 M.2.4.1 The Domestication of the Western Pacific
Veronica M. Ahern

252 M.2.4.2 The Introduction of Direct-to-Home Satellite Services into Canada: When Policy, Regulatory and Business Strategies Collide
Anthony H.A. Keenleyside

262 M.2.4.4 The Informatization of Japan: Creating an Information-Society or Just Good Salesmanship?
Jonathan M. Jaffe

274 M.2.5.2. Advanced Networks = Information, Education, Economic Development, Social Development
David R. Block

280 M.2.5.3 Critical Obstacles to Telecommunications Development in Developing Countries
Ryota Ono

290 M.2.6.1 The Building Blocks for Competitive Information Infrastructure
Andrew D. Lipman

298 M.2.6.2 Privatization: A Strategic Management Perspective
Diane Landau

308 M.2.6.3 Reforms in the Indian Telecom Sector
T.H. Chowdary

313 M.2.6.4 How Competition Will Change Management Strategies of Telecommunications Operators
Philip Parker, Michael Kelly, Stephen Hains

319 M.2.7.1 Toward a Global Network: The Evolution of Wide Area Networking in Rohm and Hass Company's Asia-Pacific Region
Lawrence H. Ostroff

327 M.2.7.2 Telecom Alliances for Emerging Economies: Breaking the Cycle of Under-Development Through Strategic Learning Alliances
Joan Kelly, Linda Booth

333 M.2.7.3 Making Information Technology Advances Work for You: BPR and Communication
Rein P Mere

342 M.2.7.4 Satellite Solutions for the Oil & Gas Industry
Rajiv Kumaraswamy

347 M.3.1.1 Mobile Satellite Services: Pie in the Sky or a Practical Solution to the Telecom Needs of the Pacific?
Donald B. Falle

354 M.3.1.2 Status of PCS in the United States
John Swart

358 M.3.1.3 PHS: A New Advanced Infrastructure for Mobile Communications and Wireless Local Loop Applications
Hideo Okinaka

366 M.3.1.4 Regulatory Aspects of an International PCS Satellite System
Edward R. Slack

372 M.3.2.1 Advanced Technology in DAMA Networking
Mark Dankberg

378 M.3.2.2 Smart-Networking-Efficient Technology Transparent Connectivity
John Puetz, Steve Hart

386 M.3.2.3 Reconceptualizing Telecommunication Delivery Systems for Rural Populations
Richard Dowling

395 M.3.3.1 Call/Connection Control in ATM Switching System for Multimedia Service
Seung-Hee Kim, Moon-Kyun Oh, Mi-Sook Han, Han-Kyoung Kim

401 M.3.3.2 Demand Forecast and Technologies Development on ATM Switching Systems in Korea
Byungryong Kang, Sungyeol Kang, Chimoon Han, Chuhwan Yim

409 M.3.3.3 A Control Scenario for Distribution Services in ATM Network
Moon-Kyun Oh, Seung-Hee Kim, Jong-Tai Lee, Han-Kyoung Kim

416 M.3.3.4 A Study on the Service Node System for Future Telecommunication Services
Sun-Moo Kang, Bu-Ihl Kim, Young-So Cho, Byung-Nam Yoon

423 M.3.4.1 Rules for an Interactive Road
Michael Reede

431 M.3.4.2 Electronic Commerce: Technology Overrules Law; The $50 Billion Pie
George E. Darby

435 M.3.4.3 The Legal Protection of Information Technology in Korea
Kyung-Han Sohn

447 M.3.4.4 Scambling Digital Images for Distribution Through Networks
Hiroshi Fujii, Noburou Taniguchi, Yasushi Yamanaka

453 M.3.5.1 Preparation for New Information Society: From Regional Cooperation to Domestic Development in the Asia-Pacific Region
Whajoon Cho, Byoung-Woo Lee

459 M.3.5.2 Politico-Economic Analysis of the Japanese Information Infrastructure Initiatives
Michael Latzer

467 M.3.5.3 A Strategic Plan for Building an Information Infrastructure: A Case for the U.S. Department of Treasury
Thomas J. McKeown, Ken Malley

476 M.3.5.4 National Information Infrastructure Policy in an Era of Global Networks
Johannes M. Bauer

484 M.3.6.1 Growth and Opportunity: Telecommunications Services Markets in APEC Countries
John W. Houghton

495 M.3.6.2 Hong Kong After 1997: The Effect on Telecommunications Services
Alan B. Kamman

505 M.3.6.3 Recent Developments Related to New Telecom Services, Private Sector Participation and Regulatory Policies in Sri Lanka
ADVN Kularatna, Gamini Gunawardana, P M Wickremasinghe, Lakmini Wijesundera

513 M.3.7.1 The Information Infrastructure: The Key to Precision Marketing for a Competitive Telecommunications Industry
Sandra B. Cook

519 M.3.7.2 The Strategic Importance of Data Warehousing in a De-regulated Telecommunications Market
Denis Tossan, Leigh Baker, Keith Budge

527 M.3.7.3 Call Data System: Flexible and Integrated Operations, Management and Control of Telecommunications Network
Yasuo Ichiya, Ichiro Kase, Kazuhiko Ogawa, Takashi Yoshida and Makoto Niimura

533 M.3.7.4 Creating Customer Loyalty Through Front-Line Sales/Service Contacts
Berth Jönsson, Bruce Carruthers, Sara Bier

Tuesday, 16 January 1996

541 T.1.1.1 Doing Business on the Internet: An Examination of Opportunities and Barriers to International Trade and Communications
Paula V. Brillson

547 T.1.1.2 Wrapped up in the Net: The Internet comes to Asia
Jeanette K. Chan

555 T.1.1.3 The Internet & Cyberspace Revolution: Implications for Developing and Developed Countries
Michael Potter

560 T.1.1.4 The Internet Goes International: Intellectual Property Considerations for Industry
Phillip L. Spector

567 T.1.2.1 Telecommunication in Slovak Education: A PSSC Legacy Project Helping Build Economy and Democracy in Slovakia
J. H. Southworth, Jozef Hvorecky

574 T.1.2.2 Creating an Inexpensive, Narrow-Band, Multifunction S/L-Band Earth Station for the Remote Pacific Islands: A challenge to the Industry, Carriers, and Funding Agencies
Bruce Best, Thomas Okamura

582 T.1.2.3 Implementing Convergent Telecommunication Technologies in Universities: How Cost-Effective, How Educationally Productive?
John M Renner

589 T.1.3.1 Designing Satellites for the Asian Region
David J. Whalen, Liang Sun-Liang

599 T.1.3.2 Trends and Applications of Satellite Operations in S.E. Asia
Roger Naff

604 T.1.3.3 The Need for a Mobile Satellite Terminal Design in Developing Countries: Mexico's Experience with Solidaridad
Luis Tellez-Giron

614 T.1.3.4 The Move to Ka-Band Satellite Telecommunications - An Assessment of Services, Availability and Performance
Louis J. Ippolito

621 T.1.4.1 Internet in China: Growth, Competition and Policy
Zixiang Tan

627 T.1.4.2 Evolving Telecommunications Regulatory Regimes in Developing Countries
Ben A. Petrazzini, Theodore H. Clark

635 T.1.4.3 Developing Competition in Local Fixed Networks in Hong Kong
M H Au

643 T.1.4.4 Local Number Portability - The Promises, And the Reality
Mike Heller

650 T.1.5.2 Telemedicine and Telehealth in the Pacific Islands Region: A Survey of Applications, Experiments, and Issues
Steven D. Bice, Greg Dever, Lori Mukaida, Scott Norton, Jimione Samisone

659 T.1.6.1 The Global Telecommunications Revolution: Building Both Information Super-Highways and Local Streets
Ryoichi Sugioka

662 T.1.6.2 Network Construction Plan for NII in R.O.C.
Steven Y. Chen, Duei Tsai

669 T.1.6.3 Future Directions for Telecommunications in Thailand
Philip Parker, Arthur Owen, Andrew Myles

674 T.1.7.1 Lotus Notes: The 90's Solutions for Telecom Carrier Business Expansion!
Larry Moore

684 T.1.7.2 Telecommunications Industry Dynamics
Massoud M. Saghafi

690 T.1.7.3 Televideo Business in Korea Telecom
Sungoh Min

698 T.1.7.4 Design and Implementation of an Enhanced Relational Database Management System for Telecommunication and Network Applications
Takashi Honishi, Nobuyuki Kobayashi, Jinnosuke Nakamura

Wednesday, 17 January 1996

707 W.1.1.1 Adding Value to Broadband Services
Reg Russ

713 W.1.1.2 Digital Technology for Program Contribution and Distribution in ABC Radio
Peter N. Kepreotes

721 W.1.1.3 High Quality Broadcast Television Transmission Based upon International Standards
Yoshiaki Nozawa, Toru Shibuya

729 W.1.2.3 ATM and Other Distance Learning Options at UC Santa Cruz
V.C. Marney-Petix

737 W.1.3.1 Remote Engine Inlet Simulation over ACTS: Why Aren't We There Yet?
Saragur M. Srinidhi, David E. Brooks, Steven C. Lin, Isaac Lopez~

743 W.1.3.2 Satellite Delivery of Wideband Service by ACTS
Douglas Hoder, Michael Zernic

752 W.1.3.3 Sharing Computational Resources and Medical Images Via ACTS - Linked Networks
David Y.Y. Yun, H. M. Chen-Garcia

760 W.1.3.4 Remote High Definition Video Post-Production Over High Data Rate Satellite: The U.S. Network Architecture
Larry A. Bergman, Burt Edelson, Neil Helm, James Pearman, Richard West, Frank Gargione

766 W.1.3.5 Remote High Definition Video Post-Production Experiment via Trans-Pacific HDR Satellite Communications Link : Experimental Systems in Japan
Naoto Kadowaki, Norio Shindo, Takashi Iida

772 W.1.4.1 The Future of the International Telecommunications Accounting Rate Regime
James Savage

781 W.1.4.2 The Impact of Boomerang Boxes and Callback Services on the Accounting Rate Regime
Robert M. Frieden

791 W.1.5.1 Telkom Indonesia: A Strategy Between Network-Based and Service-Based Expansion
B. Widjajanto, Agung Sutanto, Dodo Rukandi, Supriyo, Endang Susilowati, Sapri Sutisna

799 W.1.5.2 Cellular telephones and pagers in Hawaii: Cultural influences on personal use patterns
Dineh M. Davis

807 W.1.5.3 A Second Look to CTSC
Dario M. Goussal

815 W.1.5.4 China's EmergingTelecommunications Infrastructure: Market Analysis and Social Impact
Jerry L. Salvaggio

821 W.1.6.1 How Banks Reengineer Through Information Technology
Vatcharaporn Esichaikul

825 W.1.6.2 Remote Education Network via Satellite Utilizing 6.7 Mbps Digital Compressed Video
Takeo Imai, Atsuo Kashiwagi

831 W.1.6.3 New Information Communication Network In Multi-Media Age
Kuniko Shimizu, Takayuki Hirakawa

837 W.1.6.4 Two-way interactive advertising in the information society
Kazumoto Inuma

845 W.2.1.1 Internet Development in the Asia Pacific Region: Challenges to Implementation
Sarah S. Lee

852 W.2.1.2 Multipoint Videoconference System
Junichi Iizawa, Yukari Kamura, Teruo Katsumi, Makoto Miyazaki, Kazuhiro Kawamoto, Isao Masuda

859 W.2.1.3 A Proposed "Open Standards" Technique for Providing Interconnectivity Between the National Communication Satellites and The Global Broadband Satellite Networks
John F. Purchase

874 W.2.2.1 The Information Superhighway: Business Opportunity or Invitation to Disaster?
Joan Abramson

881 W.2.2.2 The Information Infrastructure: Opportunities and Decisions
John Spence

887 W.2.2.3 Videoconferencing Using VSAT
Dave Rehbehn

894 W.2.2.4 Mobile Business Applications - Examples of Global Applications Through Existing Satellite Networks and Those in Planning
Ramin Khadem

901 W.2.3.1 Software Opportunities in the Information Infrastructure
Saurabh Srivastava

904 W.2.3.2 Enabling Software Capabilities for the Global Information Infrastructure
Richard S. Wolff

912 W.2.3.3 Role of Intelligent Agents in the Information Infrastructure
Don Gilbert, Manny Aparicio, Betty Atkinson, Steve Brady, Joe Ciccarino, Benjamin Grosof, Pat O'Connor, Damian Osisek, Steve Pritko, Rick Spagna, Les Wilson

920 W.2.4.1 The Political Economy of India's Telecommunication Reforms
Nikhil Sinha

928 W.2.4.2 The Indonesia Approach to Developing an Information Infrastructure for the coming Multimedia Age
Aviadi H. Purnomo, Indra Utoyo

934 W.2.4.4 The Pacific Telecommunications and Information Infrastructure: Leap-Frog or Widening Gap?
Norman H. Okamura, Edmond Durand

948 W.2.5.1 Strategies for Working in Collaboration to Support Emergency Management Communications in the North, Central and Western Pacific
Christina Higa, Dave N. Kennard, Jerry B. Norris, Marilyn Shigetani

957 W.2.6.1 The Future of Private Submarine Cable: New Cables and Economic Opportunity
Neil Tagare

959 W.2.6.2 Mid-Range Undersea Cable System Applications for Emerging Markets
Kathleen A. Kurek, Elin C. Upperco

966 W.2.6.3 Fiber Optic Submarine Cable Systems: An Opportunity for Emerging Markets to Access the Global Highways and Super Highways
John Warta

972 W.2.6.4 Installation and Burial of a 240 Kilometer Long "ASN 14mm" Fiber Optic Telecommunication Cable in Bass Strait Using the "Ship-Of-Opportunity" Installation Technique
Michael R. Harrison, Brett Worrall

984 W.2.7.1 Financing the Global Information Infrastructure
Lionel H. Olmer

991 W.2.7.2 Taking Advantage of the Information Economy
Paul Mallam

997 W.2.7.3 Infrastructure: A Revisionist Plea
Donald M. Lamberton

1004 W.2.7.4 Financing for Development of Telecommunications Infrastructure: Various Means to Accumulate Capital for constructing and Enhancing Telecommunications Networks in Asian Economies
Mamoru Udaka

SUBJECT INDEX

Section	*Subject*
M-3.1 T-1.4 T-1.6 W-1.4	Accounting rates/tariffs
T-1.3 W-1.3 W-2.1	ACTS (NASA Advanced Communications Technology Satellite)
M-1.3	Afro-Asian Satellite Corporation (ASC)
M-1.3	AGRANI satellite system (ASC)
M-1.1	Alliances
M-2.1 W-2.2	ALOHA protocol
W-2.5	Amateur radio
M-1.3	AMPS
M-3.1	American National Standards Institute (ANSI)
M-3.1	AMSC
M-1.5	Apstar
M-1.4 M-3.5 M-3.6 T-1.1 W-2.7	APEC : Asia-Pacific Economic Conference
M-3.5 T-1.1	APII : Asia-Pacific Information Infrastructure
W-2.7	APT : Asia-Pacific Telecommunity
M-1.1 M-2.1 M-2.2 M-2.7 M-3.3 T-1.7 W-2.1	Area networks (LAN/WAN)
M-1.5 T-1.3	AsiaSat satellite system
M-2.1 M-2.2 M-3.3 T-1.6 W-1.2 W-1.3 W-1.5 W-2.1 W-2.4	ATM
M-1.7	Authentication procedure(s)
T-1.3 W-1.3	Bandwidth on demand
W-1.6	Banking technology
M-1.5 M-3.2	BER (bit-error ratio)
M-2.1 M-3.4 T-1.6 W-1.1 W-1.3	Broadband applications
M-1.5 M-3.3 T-1.6 T-1.7 W-1.1 W-1.3 W-1.5 W-2.1 W-2.4	B-ISDN
M-1.5 M-3.2	BPSK (bipolar phase-shift keying)
M-2.4 T-1.6 W-1.1	Broadcasting policy
M-1.1 M-1.5 M-1.6 M-2.4 T-1.3 W-2.1	Broadcasting satellite service (BSS)/ Direct broadcasting satellites (DBS))/ Direct-to-home (DTH)

M-3.3 W-1.1	Broadcasting technology
M-1.1 M-1.4 M-1.5 M-2.4 M-3.1 M-3.5 T-1.7	Cable television - CATV
M-2.2 W-1.4	Call back
M-3.7	Call data system (CDS)
T-1.3	C-band satellites
M-1.4 M-2.4	Canadian Radio-television and Telecommunications Commission (CRTC)
M-1.2 M-1.4 M-1.6 M-2.5 M-3.6 W-2.7	Capital investment and spending
M-1.3 M-3.1 M-3.4 W-2.1 W-2.2	CDMA
M-1.1 M-1.3 M-3.1 M-3.6 T-1.3 W-1.5 W-2.1	Cellular applications
M-3.1	CEPT (European Conference of Post and Telecommunications)
W-2.7	CITEL
W-1.1 W-1.5 W-2.1	CODECs (coder-decoder) for television or video
M-3.4 M-3.5 T-1.1 T-1.4 T-1.7 W-1.6 W-2.2 W-2.3 W-2.6	Commerce on the Internet
W-1.5	Community Teleservice Centers (CTSC)
M-1.4 M-1.5 M-2.2 M-2.6 M-3.5 T-1.4 T-1.7 W-1.1 W-1.5 W-2.4 W-2.6	Competition/privatization
M-1.5 M-2.4 W-1.1 W-1.6	Compression of digital signals
M-1.1	Computer aided design (CAD)
M-1.1	Computer-aided manufacturing (CAM)
M-1.1	Computer-telephone integration (CTI)
M-1.4 T-1.3 W-2.2	COMSAT
M-1.1	Concurrent engineering
M-1.1 M-3.4 M-3.5 M-3.7 T-1.2 T-1.6 T-1.7 W-2.4	Convergence
M-3.4 W-1.1	Copyright and patent laws

M-1.1	Country profiles
M-1.3	Courier satellite system
M-2.4 M-3.5 T-1.5 W-2.1	Cultural aspects
T-1.3 W-2.1	CyberStar satellite system
	DAB/DSB (see DSB)
M-1.1 M-3.2 T-1.3 T-1.7	Data communication services
M-1.2 M-3.7 T-1.7	Database services
M-3.7	Data warehousing
W-1.1	Digital sound broadcasting (DSB/DAB)
W-2.2	Decision analysis (DA)
M-1.5 M-2.1 M-3.2	Demand-assigned multiple-access (DAMA)
M-1.5	Demodulation
M-1.3 M-1.4 M-2.5 M-3.7 T-1.7 W-2.4	Deregulation
M-1.3 M-1.6 M-2.5 M-3.1 M-3.5 T-1.1 T-1.3	Development, applications/technologies
M-1.3 M-1.6 M-2.5 T-1.4	Development costs
M-1.1 M-1.2 M-1.3 M-1.6 M-2.1 M-2.2 M-2.5 M-3.5 M-3.6 T-1.1 T-1.3 T-1.4 W-1.5 W-2.1 W-2.4 W-2.7	Development, economic/political/social issues
M-1.6 M-2.5 M-2.7 M-3.5 M-3.6 T-1.4 W-2.1	Development, mutilateral/international policies
M-1.6 M-2.2 M-2.5 M-2.7 M-3.5 M-3.6 T-1.4 W-2.1	Development, national policies
M-1.6 M-2.5 M-3.5 T-1.1 T-1.3	Development, technology transfer
M-1.6 M-2.5 M-3.2 M-3.6 T-1.3 T-1.5 W-1.5 W-2.4	Development of rural infrastructure

M-1.5 M-3.2	Digital modulation techniques
M-1.5 M-2.4 W-1.1 W-1.6	Digital signal compression
	Direct broadcasting satellites (DBS) (see Broadcasting Satellite Service (BSS))
	Direct-to-home (DTH) (see Broadcasting-satellite service (BSS))
M-1.6 W-2.5	Disaster/emergency communications
M-1.6 M-2.5 T-1.2 T-1.3 W-1.2 W-1.5 W-1.6	Distance education/learning
T-1.3 W-1.3	Earth stations, advanced
M-1.3	ECO satellite system
M-1.4	EDI
M-2.1 M-3.4 M-3.5	Electronic commerce
	Emergency communications (see Disaster communications)
M-3.4	Encryption/scrambling
W-1.1	ETSI - European Telecommunication Standardization Institute
M-1.4	European Union
M-1.4 M-3.1 W-1.4 T-1.3 W-2.1 W-2.2	FCC

M-2.3 M-3.2 W-1.1 W-1.3	FEC (forward error correction)
M-2.1 M-3.2 W-2.1	FDMA (frequency-division multiple-access)
W-2.6	Fiber optic systems and hybrid systems
M-2.5 W-2.7	Financing and financial strategy
T-1.3 W-2.1	Fixed-satellite service (FSS)
M-3.1	Fixed wireless
W-2.6	FLAG submarine cable system
M-2.2 M-3.2	Frame relay
M-1.1	FTTC (Fiber to the curb)
M-1.1	FTTH (Fiber to the home)
M-1.6	Galaxy satellite system
T-1.1 W-2.7	G-7
M-1.4 M-3.6 T-1.1	General Agreement on Trade in Services (GATS)
W-1.3	Gigabit satellite network (GSN)
M-1.5 M-1.6 M-2.5 M-3.5 T-1.1 T-1.4 T-1.6 W-2.3 W-2.4 W-2.7	Global Information Infrastructure (GII)
M-1.3 M-3.1	GLOBALSTAR satellite system

M-1.3	*Gonets* satellite system
M-1.5 W-2.1	GPS (Global Position System)
M-1.3 M-3.1	GSM (Global System for Mobile Communications)
W-1.3	High-data rate earth stations (HDR)
M-3.4 W-1.3	HDTV/digital TV/high definition video
M-1.3 M-3.1 W-2.2	ICO satellite system
M-1.4 M-1.5 T-1.6 T-1.7 W-2.2 W-2.6	Information highway
M-1.6 M-2.6 M-3.5 M-3.7 W-2.2 W-2.3 W-2.4 W-2.7	Information infrastructure
T-1.3	Information services
M-2.4 M-2.6 M-3.5 W-2.7	Information society/economy
M-2.1	Information system(s)
M-2.7 M-3.4 M-3.7	Information technology (IT)
M-1.3 M-1.5 M-2.7 M-3.1 T-1.3 W-2.2 W-2.5	INMARSAT

W-1.5	Integrated Rural Development (IRD)
T-1.1	Intellectual property and IPR
M-1.4 M-1.5 M-2.7 M-3.1 T-1.2 T-1.3 W-1.4	INTELSAT
M-1.7 W-1.5 W-2.3	Intelligent networks
W-1.5	Intelligent terminals
W-1.6	Interactive advertising
M-1.1	Interactive media services (IMS)
M-1.1	Interactive television
M-2.6 M-3.1 M-3.2 T-1.4 W-2.1 W-2.7	Interconnectivity/interconnection issues
M-1.3 M-1.4 M-1.6 M-1.7 M-2.2 M-2.5 M-2.7 M-3.1 M-3.3 M-3.6 T-1.1 T-1.3 W-1.1 W-1.4 W-2.1 W-2.7	International Telecommunication Union (ITU)
M-1.1 M-1.2 M-2.7 M-3.2 M-3.4	Internet and Internet Services

M-3.5 M-3.6 T-1.1 T-1.4 W-1.6 W-2.1 W-2.4 W-2.6	Internet and Internet services (*Continued*)
	Internet protocols (see Protocols)
W-2.1	Inter-satellite links (ISLs)
M-1.4 M-1.5 M-3.6 T-1.4 W-2.7	Investment costs and strategies
M-1.3 M-3.6	Investment prospects
M-3.1 W-2.1	IRIDIUM satellite system
M-1.3	IRIS satellite system
M-1.5 M-2.2 M-2.7 M-3.1 M-3.7 T-1.6 W-2.1 W-2.4	ISDN and B-ISDN
M-3.4 T-1.1 W-1.1 W-2.1	ISO and IEC
M-1.3	Joint ventures
T-1.3	K-band satellites
M-1.3	KITCOM satellite system
T-1.3	L-band satellites
T-1.4 W-1.5 W-2.7	LDCs (Least or Less developed countries)

M-1.4 M-2.2 M-2.7 M-3.4	Legal issues
M-2.7	Legislation/Legislative framework
M-1.1 M-1.3 M-1.4 M-1.5 T-1.3 W-2.4	LEO satellite systems
M-1.1 M-1.4 W-2.4	Liberalization
M-1.2	Libraries (digital)
M-2.6 M-3.1	Licensing
	Local-area networks (LANs) See Area networks
T-1.3	Local multipoint distribution service (LMDS)
	Maritime satellite services (See Mobile satellite services)
W-1.5 W-2.6	Market analysis
M-3.7 T-1.7 W-2.2 W-2.7	Marketing strategies
M-1.3 M-3.1	MiniSat satellite system
M-3.6	Mobile network
M-1.3 M-3.1 T-1.3 W-2.2	Mobile satellite services (MSS)
M-1.5	Modems

M-1.5 M-3.2	Modulation techniques
M-1.1	MMDS
T-1.7 W-1.1	MPEG - Motion Pictures Expert Group
M-3.3	Multicasting
M-1.1 M-1.5 M-1.6 M-2.1 M-2.2 M-3.1 M-3.5 T-1.3 T-1.7 W-1.6 W-2.3 W-2.4	Multimedia
M-3.2	Multiple-channel-per-carrier (MCPC)
See MMDS	Multipoint, multichannel distribution systems (MMDS)
T-1.3	MSAT satellite system
M-3.5 T-1.1 T-1.4 T-1.6	National Information Infrastructure (NII)
M-1.4	Negotiating Group on Basic Telecommunications (NGBT/GATS)
	NAFTA (see North American Free Trade Agreement)
M-1.1 M-3.4	Netscape
M-1.4 M-1.6 M-1.7 M-2.1 M-2.2 M-3.3 T-1.6 W-1.3 W-1.6	Network architectures

M-1.7 M-2.7 M-3.5 M-3.7 T-1.7 W-1.5 W-2.3	Network management and network management systems
T-1.7 W-1.5	Network management terminal (NMT)
M-1.5 M-2.2	Network infrastructure
M-2.2 W-1.5	Network planning
T-1.3	Non-geostationary orbit satellite systems (NGSO/FSS and NGSO/MSS)
T-1.3	NorStar satellite system
M-1.4	North American Free Trade Agreement (NAFTA)
M-1.7 M-2.4 M-2.6 T-1.4	Numbering issues and system(s)
M-1.3 M-1.4 M-3.1	ODYSSEY satellite system
M-2.5 T-1.1	OECD (Organisation of Economic Cooperation and Development)
M-3.4	Open access
M-1.5 W-2.1	Open Systems Interconnection (OSI)
M-2.3	Optical amplifiers
T-1.3	OPTUS satellite system
M-1.3 M-3.1	ORBCOMM satellite system
M-1.2	Pacific Islands Business Network (PIBN)
M-1.5	PALAPA

M-1.4 M-1.5	PanAmSat
M-1.1	Pay-per-view (PPV)
M-1.1 M-3.4	Pay TV
M-1.2 T-1.2 T-1.5 W-2.4 W-2.5	PEACESAT
M-1.1 M-1.3 M-1.4 M-1.5 M-1.7 M-3.1 W-2.1 W-2.2	Personal communications (PCS)/FPLMTS
M-1.4	Personal communications satellite system
M-3.1	Personal handy-phone system (PHS)
M-2.4 M-2.5 T-1.4 W-1.4 W-1.5 W-2.1 W-2.7	Policy issues
M-1.5	PSK (phase-shift keying)
M-1.4 M-3.7 T-1.7 W-2.4	POTS
	Private sector investment (See investment costs and strategies)
M-2.3	Procurement issues
T-1.3	Propagation considerations (in space communications)
M-2.1 M-3.2 M-3.4 T-1.1	Protocols, Internet
W-1.3 W-2.1	Protocols, Internet (*Continued*)
M-2.1	Protocols, satellite software broadcast
W-2.1	PSDN (public switched data network)
M-1.5 T-1.6 T-1.7 W-2.1	PSTN (public switched telecommunication network)
M-1.1 M-1.2	Publishing and desktop publishing
M-1.5	QAM (quadrature amplitude modulation)
M-1.5 M-3.2 W-1.1 W-2.1	QPSK (quadrature phase-shift keying)
M-1.3	Radiocommunication systems
M-1.3	Railway telecommunication networks
M-1.5	Reed-Solomon techniques
M-2.2	Redial
M-2.2	Refile
M-2.2	Resale
M-2.6	Reciprocity
M-1.1 M-2.2 M-2.4 M-2.5 M-2.7 M-3.1 M-3.4 T-1.3 T-1.4 T-1.6	Regulatory issues
M-3.6	Revenue
M-1.5	RimSat

M-3.1 M-3.2 T-1.3 T-1.5	Rural and remote applications
M-1.6 M-3.2 M-3.6 T-1.3 T-1.5 W-1.5 W-2.4	Rural infrastructure development
M-1.3	S-80 TAOS satellite system
M-1.3	SAFIR satellite system
M-2.7 M-3.1 W-1.3 W-2.2	Satellite applications
M-1.5 M-2.5 W-1.3	Satellite communications, advanced
M-3.1	Satellite newsgathering (SNG)
	Satellite organizations (see EUTELSAT,INMARSAT,INTELSAT)
M-1.1 M-1.3 M-1.4 M-1.5 M-3.1 T-1.3	Satellite systems - LEOs and MEOs
M-1.3 M-3.1 M-3.2 T-1.3	Satellites systems, rural applications
W-1.3	Satellite technologies
T-1.3	S-band satellites
M-3.4	Scrambling/cryptography
M-3.4 M-3.5 T-1.1 W-2.1	Security issues
M-3.3	Service Node System (SNS)
	Settlement rate (See Accounting rates)
M-1.3	*Signal* satellite system
M-3.3	Signalling protocols
M-1.5 M-3.2 W-1.3	Signal-to-noise ratio, SNR (*Eb/No*)
M-1.5 M-2.1 M-2.7 M-3.2 T-1.3 W-1.1 W-2.2	Single-channel-per-carrier (SCPC)
M-1.6 M-2.1 M-2.4 M-2.5 M-3.5	Socio-economic issues
W-2.3	Software
M-2.2 T-1.6 W-1.3 W-1.5 W-2.1	SONET (Synchronous optical network)
M-1.2	South Pacific Forum
M-1.3 T-1.3 W-2.1	SPACEWAY satellite system
M-1.1 M-1.3 M-1.5 M-3.1 T-1.3	Spectrum management and allocation
M-1.7	SS7 network management

M-1.3 M-1.4 M-1.6 M-1.7 M-2.2 M-3.1 M-3.4 T-1.3 T-1.5 W-1.1 W-2.1 W-2.3 W-2.7	Standards or standards issues
M-2.2 M-3.6 W-2.4	Strategic alliances
M-1.6 M-2.3 W-2.4 W-2.6	Submarine cables and systems
M-2.3	Submarine optical amplifiers
M-1.7 M-3.3	Switching technology
M-2.2 W-1.5 W-2.1	Synchronous data hierarchy (SDH)
M-2.1	System integration
M-2.1 M-2.7 M-3.1 W-1.3 W-2.2	TDMA and satellite-switched TDMA
M-1.1	Teleconferencing
M-1.3 M-3.1 T-1.3	Teledensity
T-1.3 W-2.1	TELEDESIC satellite system
M-1.1	Telephony Services Application Programming Interface (TSAPI)
M-1.7 T-1.7 W-1.5 W-2.3	Telecommunication network management and Telecommunication Management Network
M-1.6 W-1.5	Telematics
M-1.6 T-1.3 W-1.3 W-1.5	Telemedicine, televeterinary
M-1.4	Telephone network
M-1.5 M-2.4 T-1.3 W-1.1	Television broadcasting
M-1.6 M-3.5 W-1.5	Telework/telecommuting
M-1.5 M-3.2	Thaicom satellite system
M-1.4	Time delay (in satellite systems)
M-2.7 W-2.1 W-2.2	Time-division multiplexing (TDM)
M-1.4 M-3.6 T-1.1 W-1.5	Trade issues
M-3.6	Traffic
M-2.5 T-1.4 T-1.7 W-2.4	Training/HRD
M-1.5	Transponder demand
W-2.1	Ultra small aperture terminals (USATs)
W-1.5	UNESCO

M-1.4 M-1.6 T-1.1 W-2.1 W-2.4	Universal service
M-1.1 M-1.4 T-1.3 W-2.3 W-2.6	Value-added services
W-2.1 W-2.2	Videoconferencing/teleconferencing
T-1.7	Video dial-tone services (VDT)
M-1.1 M-1.5 M-3.4 M-3.7 T-1.7	Video on demand
M-3.7	Videotex
M-1.2	Virginia Commonwealth University (VCU)
M-1.3	VITA (Volunteers in Technical Assistance)
M-1.5	Viterbi coding
M-1.7	Voice mail service
M-1.5 M-2.2 M-2.7 M-3.2 T-1.1 T-1.3 W-1.5 W-2.1 W-2.2 W-2.4	VSATs and VSAT networks
	Wide-area networks (WANs) See Area networks
W-1.3	Wideband services
M-1.1 M-1.3 M-1.4 M-1.7 M-3.1 M-3.5 M-3.6	Wireless communications and services
M-1.3 M-3.1 M-3.6	Wireless local loop (WLL)
W-1.5 W-2.7	World Bank
T-1.1	World Intellectual Property Organisation (WIPO)
M-3.1	World Radiocommunication Conference (WRC-95)
M-2.5 T-1.1 W-1.5	World Telecommunication Development Conference (WTDC/ITU)
M-1.4 M-3.6 T-1.1	World Trade Organization (WTO)
M-1.1 M-1.2 M-2.7 M-3.2 M-3.4 T-1.1 W-1.6	World Wide Web (WWW)
M-2.1 M-3.2 W-2.1	X.25 telecommunication protocol
W-2.1	X.400 telecommunication protocol
T-1.3	X-band satellites

COUNTRY AND REGION INDEX

Note:- Entries concern the country or region with regard to individual projects or within the context of a given analysis.

Section	*Country or region*
M-1.1	Africa
M-3.2	Alaska
W-2.4 W-2.5	American Samoa
M-1.1	Americas
M-3.6 T-1.1	APEC Countries (Asia-Pacific Economic Conference)
W-1.5 W-2.6	Argentina
M-1.3 T-1.1	ASEAN
M-1.3	ASEAN Cellular Satellite System (ACES)/Garuda
M-1.1 M-1.3 M-1.4 M-1.5 M-2.5 M-2.7 M-3.1 M-3.5 T-1.1 T-1.3 W-2.1 W-2.7	Asia-Pacific
M-1.1 M-1.2 M-1.3 M-1.4 M-1.5 M-2.6 M-2.7 M-3.5 M-3.6 T-1.3 W-1.1 W-2.1 W-2.4 W-2.6	Australia
M-1.6	Bangladesh
M-1.1 M-1.3 W-1.5 W-2.6	Brazil
M-1.5 M-3.6	Brunei
M-1.4 M-2.4 M-3.1 M-3.5 M-3.6 T-1.1 T-1.3 W-2.4	Canada
W-2.5 W-2.6	Caribbean
M-2.6 M-3.5 M-3.6 W-2.4 W-2.6	Chile
M-1.3 M-1.5 M-2.7 M-3.1 M-3.5 M-3.6 T-1.1 T-1.3 W-1.5 W-2.1 W-2.3 W-2.7	China
W-2.6	Colombia
M-1.1 M-1.3	Commonwealth of Independent States (CIS)
M-2.4 T-1.2 W-2.4 W-2.5	Commonwealth of the Northern Marianas (CNMI)

M-1.2 W-2.4	Cook Islands
M-2.6	Denmark
W-2.6	Ecuador
M-1.1 M-1.4 M-2.3 M-3.1 M-3.5 W-1.5 W-2.4 W-2.6	Europe/European Union
M-1.2 T-1.2 W-2.4 W-2.5	Federated States of Micronesia
M-1.3 W-2.4	Fiji
M-1.4 M-2.6	France
M-1.4 M-2.6	Germany
M-2.4 T-1.2 W-2.4 W-2.5	Guam
W-2.6	Honduras
M-1.1 M-2.5 M-2.6 M-3.1 M-3.5 M-3.6 T-1.1 W-2.4	Hong Kong
M-1.1	Iceland
M-1.3 M-1.5 M-1.6 M-2.6 M-2.7 T-1.1 W-2.3	India

W-2.4 W-2.7	India (*Continued*)
M-1.1 M-1.3 M-1.4 M-1.5 M-2.5 M-2.7 M-3.5 M-3.6 W-1.5 W-2.4 W-2.6 W-2.7	Indonesia
W-2.6	Italy
M-1.4 M-1.5 M-2.1 M-2.4 M-2.5 M-2.6 M-3.1 M-3.5 M-3.6 T-1.1 T-1.4 W-1.1 W-1.3 W-1.6 W-2.1 W-2.4 W-2.7	Japan
M-1.2 W-2.4	Kiribati
M-1.1 M-1.7 M-2.5 M-3.3 M-3.4 M-3.5 M-3.6	Korea
M-3.1 W-1.5 W-2.6	Latin America
M-1.4 M-2.6 M-2.7 M-3.1 M-3.6	Malaysia

T-1.1 W-2.7	Malaysia (*Continued*)
T-1.2 W-2.4 W-2.5	Marshall Islands
M-1.1 M-1.6 M-2.6 M-3.1 M-3.5 M-3.6 T-1.3 W-2.6	Mexico
M-1.3	Middle East
M-1.1	Mozambique
W-2.4	Nauru
M-1.2 M-1.4 M-2.6 M-3.5 M-3.6 T-1.4 W-2.4	New Zealand
W-2.4	Niue
M-1.4	North America
M-1.1 M-1.2 M-1.5 T-1.3	Oceania
M-1.2 W-2.4	Pacific Islands
M-1.2 M-1.6 T-1.2 W-2.4 W-2.5	Palau
W-2.6	Panama
M-1.2 M-1.5 M-3.5 M-3.6 W-2.4	Papua New Guinea
W-1.5	Paraguay
M-1.1 M-1.3 M-1.4 M-1.5 M-2.5 M-2.7 M-3.1 M-3.5 M-3.6 T-1.1 W-2.4	Philippines
W-2.4	Pitcairn
M-1.5	Polynesia
M-1.3	Russia/Russian Federation
M-1.3 M-1.4 M-1.5 M-2.5 M-2.6 M-3.6 T-1.1 W-2.3 W-2.4	Singapore
T-1.2	Slovakia
M-1.2 W-2.4	Solomon Islands
M-1.3	South Africa
T-1.3	Southeast Asia
M-1.3 W-2.6	Spain
M-3.6 T-1.1	Sri Lanka
M-2.6	Sweden
M-2.6	Switzerland
M-1.2 W-2.4	Tahiti
M-1.5 M-3.6 T-1.1	Taiwan

T-1.6 W-2.1 W-2.4	Taiwan (*Continued*)
M-1.1 M-1.3 M-1.4 M-1.5 M-2.2 M-2.7 M-3.5 M-3.6 T-1.1 T-1.6 W-2.7	Thailand
M-1.2 M-1.5 W-2.4	Tonga
M-1.2 W-2.4	Tuvalu
M-1.1 M-1.4 M-2.6	United Kingdom
M-1.1 M-1.4 M-1.7 M-2.6 M-3.1 M-3.2 M-3.5 M-3.6 T-1.1 T-1.3 W-1.2 W-1.3 W-1.5 W-2.4 W-2.6	United States
M-2.4	United States Pacific Territories
W-2.6	Uruguay
M-1.2 W-2.4	Vanuatu
M-1.1	Venezuela
M-1.2 W-2.4	Western Samoa
M-1.3 M-2.7	Vietnam

W-2.7	Vietnam (*Continued*)

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NOTES:

CATV-TELEPHONY CONVERGENCE IN ASIA

Alexandra Rehak & Achmad Chadran
Pyramid Research, Inc.
Cambridge, MA., USA & Singapore

ABSTRACT: The convergence of telephony and cable television technologies is fast becoming a reality, and Asia, with its burgeoning investment in telecommunications infrastructure and hunger for the latest technologies, is the site of a number of convergence services initiatives. This paper discusses the regulatory issues and major players involved in convergence networks and services in Asia. Specific examples of convergence services regulation and initiatives in the Philippines, Thailand, Korea, Hong Kong, and Australia will be examined.

I. Introduction

Liberalization in telecommunications services, coupled with a variety of technological innovations, is fueling a convergence of telephony and cable television technologies in Asia. This convergence has already begun to revolutionize telecommunications development. New players, new alliances, and new technological solutions for transmission and program distribution have begun to develop. The trend towards convergence will also lead to new strategies for sector reform, since cable TV service providers are just as interested in entering the telephony segment as voice carriers are in entering the CATV market.

Due to the diverse regulatory environments surrounding these initiatives, the evolution of this burgeoning industry has taken a very different track in each country. In Hong Kong, for example, the convergence of cable television, data communications, and telephony will be managed by regulator OFTA with an eye toward maximizing -- not limiting -- competition. In contrast, in Korea the authority to provide cable TV service will be limited to two companies: KEPCO -- the country's electric power company -- and Korea Telecom. This paper will explore the variety of regulatory issues surrounding CATV/telephony convergence in Asia, including the combined regulation of CATV and and telephony by a single authority, the regulation of content, and the structuring of competition in the market to ensure maximum efficiency. After discussing the regulatory issues involved in convergence services, the paper will move to a discussion of opportunities available for both operators and equipment suppliers in the convergence services market. Finally, specific country examples will be discussed, with attention to the market conditions prevailing in each country and the specific technologies being implemented.

II. Regulatory Issues

Telecommunications and CATV services regulators face a number of pressing new issues related to the convergence of these services. Should broadcasting and telephony authorities be combined into a single entity? Given the rapid intertwining of these two services, this is a logical step, but political considerations have made it an issue of contention in most countries. Regulators must also decide whether a single set of policy guidelines should be developed for broadcasting and telephony, so that the industry and the networks develop in a rational and efficient manner. The question of content regulation also arises; regulators must decide whether to regulate voice and video uniformly.

Regulators must walk a fine line, encouraging competition while ensuring that the telecoms and CATV markets do not become dominated by a few strong providers. Allowing CATV and telephony services to be provided by the same operators does open the market to this risk. However, regulators around the world are bowing to the demands of the market and of the operators themselves; after all, liberalization encourages the construction of additional lines, the development of new advanced services and more innovative programming, and the lowering of prices. In developing countries, allowing operators to provide both types of services over one network can significantly increase main line penetration, one of the primary goals of regulatory authorities.

Regulatory strategies vary considerably from country to country. In some countries, notably Australia, Thailand, and to a certain extent Korea, it is the telephony service providers that are being encouraged to develop such mass-media services as video-on-demand, pay-per-view, and interactive television. In Taiwan and the Philippines, in contrast, cable service providers may soon get the green light to offer value-added and data communications services, and possibly basic voice services as well. In nearly every case, the doors are being opened to private sector participation, and in certain countries to foreign participation as well.

III. Operator Strategies

Why should a cable TV provider be interested in providing voice services, or a telephone service provider be interested in providing cable TV services? The answer comes down to economies of infrastructure and increased revenues. Throughout the world, liberalization is breaking down the once-impassable barriers between these two areas of service. The U.K. offered one of the first examples of successful commercial implementation of CATV/telephony convergence: cable company NYNEX CableComms. NYNEX CableComms has successfully provided access to 604,000 homes, or over 24% of the 2.5 million homes in its 16 franchise areas. NYNEX's U.K. network is based on a "co-deployed" fiber-coaxial system, which allows simultaneous delivery of digital telephony and analog video through the same wire sheath. NYNEX CableComms' customer growth rate from 1993 to 1994 was 110% in CATV operations and 186% in residential relephony; the operator now has nearly as many telephony subscribers as cable TV subscribers.

Inspired by examples such as this, a number of major service providers have jumped into convergence services development in Asia. On the voice services side, active operators include U.S. RBOCs BellSouth, NYNEX, and USWest. On the CATV side, U.S. CATV operators Continental Cablevision, Tele-Communications, Inc., Time Warner Cable, and United International Holdings have all invested in CATV/telephony trials or networks in Asia.

Nor are opportunities for operators limited to larger service providers. One useful model being applied in Korea distinguishes three different components in the provision of convergence services: network operators, system operators, and program providers. Network operators, which in Korea are currently Korea Telecom and Korea Electric Power Company (KEPCO), own and operate the hardware for broadcasting and transmission; this includes local distribution systems and CATV feeder lines, which serve the same function as trunk lines in a traditional telephone network. System operators market and sell CATV services, and connect subscriber homes to the network operators' distribution networks; they are functionally equivalent to local telephone service providers who do not operate their own trunk networks but must lease trunk lines from a larger network operator. Finally, program providers provide the content for the CATV channels by producing or purchasing programming which they sell to the system operators.

While Korea has only licensed a few network operators, there are over 26 licensed program providers and over 54 system operators. If network operators decide to offer voice services over their networks, then the system operators will be a key part of their network strategy, since system operators provide the portion of the network which goes directly to subscriber homes. The Korean model will also be applicable elsewhere in Asia; just as regulators have carved out separate spaces for local and long distance voice carriers, these distinctions may be carried over to the CATV arena as smaller local voice carriers and local CATV providers team up with trunk network operators to provide convergence services. In some cases these local networks will serve as a base on which to build a trunk network: for example, new Chinese carrier China Unicom is considering building local CATV/voice networks as the first step to establishing its planned nationwide network.

IV. Technologies & Players

As with the process of regulation and administration of cable TV and telephony, numerous models have emerged for the technique of convergence itself. The technology involved in offering cable TV services and telephony over the same network is already in existence, making the prospect of offering both services even more appealing to operators. The technology rests primarily in the access network; trunk lines are simply broadband networks with sufficient capacity to permit them to carry both voice and video.

For terrestrial wireline access, several solutions exist which permit voice and CATV transmission to the subscriber. Fiber-to-the-home and fiber-to-the-curb solutions are one option. While the most expensive option, optical fiber can support the greatest number of applications and delivers the highest transmission quality. Fiber to the curb is a more economical solution, since the last portion of the outside plant is normally copper extending from a single fiber link to 4 or 8 subscribers. Hybrid fiber-coax cable also permits the transmission of voice and video to the subscriber. While less expensive than fiber, HFC Cable has been criticized for quality of transmission, with subscribers complaining of fading and crossed signals. Coaxial cable is the least expensive of the wireline access options, but cannot be used for longer distances and has less capacity than other wireline methods.

Wireless and satellite access for CATV/telephony services is also available. Multipoint multichannel distribution systems (MMDS) are being tested as solutions in areas where rights of way are an issue, and where operators are experienced in providing wireless rather than wireline services. For example, Thailand's two entrenched subscription television operators, INC and Thai SkyCable, use MMDS via UHF-band radio to reach their subscribers. However, the two operators are beginning to migrate subscribers to a satellite-based access solution known as DTH (Direct-To-Home), which permits programs and potentially voice to be transmitted via satellite directly to the subscriber, bypassing the need for a local distribution node. An alternative satellite solution, DBS (Direct Broadcast Set), transmits as far as the local distribution center; wireline or wireless access solutions are then used to connect to the subscriber.

The development of a convergence service market is leading to interesting developments on the equipment front, as vendors of cable distribution and terminal systems butt heads against the data communications and multiplexer vendors. On the cable side, some of the more active vendors include General Instruments, American Lightwave Systems, C-COR, and Zenith. Newer players offering integrated access platforms using hybrid fiber-coax architecture include ADC Telecommunications, working with its subsidiary American Lightwave Systems. U.S. vendor Tellabs provides a solution which permits the delivery of telephony over a CATV network through interfacing copper, fiber, and hybrid fiber coax cable. Meanwhile, a host of vendors known primarily for their work in telephony -- including Northern Telecom, Augat, Siemens, AT&T, Alcatel, and Scientific Atlanta -- have begun to introduce products to enable television and telephony to be transmitted simultaneously.

Some countries, such as Korea, are developing their own convergence equipment vendors; Korean vendors active in this area include Goldstar, Hyundai, Samsung, Bando Electronics, Yangjae Systems, Opicom, and Jinwoo. Some foreign vendors are also establishing production beachheads in Asia which will supply partial or total covergence services solutions in the region. ADC, for example, formed a joint venture in Shanghai at the end of 1994 to manufacture fiber-optic video transmission equipment under license from American Lightwave Systems.

V. Country Profiles

To understand the magnitude of the changes taking place in Asia's telecom environment as a result of the convergence of telephony and cable TV, it is helpful to examine the regulatory conditions and convergence service initiatives in several Asian countries. Convergence services are already underway in some countries, with operators licensed to provide both telephony and CATV and networks being built out. In other countries regulatory or infrastructure barriers will delay convergence in the near term, but it is expected that these barriers will not withstand the combined pressure of operator interest and subscriber demand.

Philippines

The Philippines now offers one of the most liberalized environments in Asia for CATV/telephony convergence. Executive Order 109, passed in 1993, is the primary impetus for the convergence of cable television and telephony over the next few years in the Philippines. Executive Order 109 mandates international gateway facility (IGF) and cellular operators to install a minimum of 300,000 and 400,000 local exchange lines respectively within three years. These carriers may offer local services via the existing cable television systems -- currently there are approximately 200 cable TV operators nationwide. In the short term, the regulatory National Telecommunications Commission will more than likely allow telephony service providers the use of cable television networks to provide basic local services. NTC is encouraging CATV operators to deploy fiber optic cables at 0.5 inch in diameter, a width capable of carrying voice traffic. In addition, NTC's Broadcast Service Department is urging CATV operators to upgrade their existing CATV networks to carry both voice and data.

Currently, no provisions or legal guidelines prohibit cable television operators from carrying telephony traffic via their facilities for third parties. NTC is also studying the possibility of allowing cable television operators to compete themselves in the provision of basic telephone services over the long term. These operators are required to establish separate franchises, however, if they intend to provide services other than cable television programming. The types of services permitted under this provision remain to be defined. To date, fewer than ten cable television providers have applied to the NTC for permission to buy a franchise.

Not surprisingly, some major cable television providers have approached the Philippines' National Telecommunications Commission (NTC) with proposals to provide telephony service; these companies are Sky Cable, the RMJ Group, Cavite Cable and Oriental Cable. Although this may be a complicated process, involving the formation of separate entities to operate the telephony component, the cable companies will probably succeed in their efforts, making the Philippines' convergence market even more dynamic. Cavite Cable T.V. Corp. has already conducted a convergence trial with assistance from U.S. CATV provider Falcon Cable T.V. The RMJ group -- a consortium of 17 cable television companies headed by Ramon Magsaysay, Jr. --intends to go into cable telephony and is currently consulting with its key CATV equipment supplier, Jerrold General Instrument.

On the telephony side, international gateway operator ICC is positioned particularly well to provide convergence service in the Philippines. The Lopez family conglomerate owns both a majority share of Benpres Corporation -- which in turn owns 75 percent of ICC -- and cable TV provider SkyCable. ICC intends to use SkyCable's networks to provide basic local telephone service to the regions where it has been mandated to install main lines. SkyCable also intends to expand its services in the Metropolitan Manila area, as well as urban areas in the northern and southern parts of Luzon, and has approached PLDT to lease fiber optic trunk lines. Further, NYNEX and TelecomAsia of Thailand intend to invest $650 million in ICC's parent company, Bayan Telecommunications Holdings Co. To date, primary carrier PLDT has expressed no interest in providing CATV service. However, PLDT will work in conjunction with local cable operator Country Communications in Alabang, a Manila suburb, for the Philippines' "First Cable Telephony Pilot Project."

Thailand

Thailand has a highly active market for convergence services, with two telephony providers moving into cable TV and a variety of new entrants in the cable TV market who are interested in telephony. Among the seven CATV licensees, three operators -- Universal Cable T.V. Network, Total Access Communication and Comlink -- intend to transmit their programming services via wireline media. Despite the many ventures in Thailand's burgeoning subscription television market, the government remains extremely paternalistic. Telephony services are limited to primary carrier Telephone Organization of Thailand (TOT) and its two concessionaires TelecomAsia and TT&T. Subscription television licenses require one of two approaches. The first involves the establishment of a joint venture with the Mass Communication of Thailand (MCOT). The second requires licensing by the Public Relations Department of the MCOT. Licenses with the PRD are cheaper than concessions with the MCOT. However, licenses are much more short-term and if not revoked can lead to fines to steer operators to follow the government's strategic plans.

Thailand's two local telephone service concessionaires have already positioned themselves as potential providers of cable television service. Along with the licensing process, they will have to obtain permission from TOT to transmit subscription television signals via TOT's trunk network, which has been controversial. TelecomAsia (TA) -- a joint venture between the conglomerate Thai Charoen Phokphand Group (85 percent) and NYNEX (15 percent) -- is installing and operating two million telephone lines under a BTO contract from TOT in the Bangkok Metropolitan Area. Thai Telephone & Telecommunication (TT&T) -- a Loxley and Jasmine International subsidiary -- has a similar contract to install and operate one million lines in the northern provinces outside of Bangkok. Both TA and TT&T recently formed subsidiary companies to offer cable television service.

TA's cable venture is Universal Cable T.V. Network (UTV), a joint venture between the Mass Communication of Thailand (MCOT), which holds a 10 percent share; the TOT with 10 percent; and Telecom Holding -- primarily owned by TA -- with a majority share of 80 percent. UTV intended to offer cable television using TA's telephony fiber optic network in Bangkok. However, in late 1994, TOT announced that it was considering a ban on the use of the TA and TT&T fiber optic networks for cable television services. UTV's strategy was to sell 10% of its shares to TOT and hope that it would be able to lease lines or draft a revenue-sharing agreement with TOT. The strategy partially succeeded. TOT granted UTV permission to use the trunk portion of the network, but rejected the proposal to use the access network.

As of 2 February 1995, UTV decided to increase its registered capital nearly 400 percent to set up its own exchanges for its subscription television service. This has resulted in a delay of UTV's service rollout, which was moved from January to 15 March 1995. The exchanges will be a joint-investment between UTV, its parent company and TOT. UTV has also entered a joint venture with Siemens AG to provide technical support for deploying fiber-in-the-loop.

Telecom Asia may also pull railway telecoms operator ComLink into its convergence scheme. TelecomAsia subsidiary Telecom Holding owns 20% of Comlink. Comlink intends to use its fiber optic network, which parallels the country's railway network, to provide cable television service before year-end 1995. Comlink may eventually lease TA's fiber optic lines to provide CATV as well.

TT&T's cable venture, TT&T Cable, claimed to have received unofficial confirmation that their cable application was approved earlier this year. Although its official license to provide cable television service is still pending, TT&T Cable Television Co. intends to use its parent company's fiber optic network. The company expects to have 100,000 homes passed and 40,000 connected subscribers by the end of 1995. The company will offer 15 channels in the first year, pay-per-view after six months in service and, eventually, interactive TV or video-on-demand (VOD) in the next few years. Assuming it wins the authorization, TT&T Cable will initially target Thailand's northern provincial populations. The company will begin a cable television test in Chiangmai and 10 other Thai provinces this upcoming April 1995. TT&T Cable Television plans to deploy additional facilities beyond the BTO contract with TOT. The expanded CATV network will cost a reported Asian industry standard of $80 per home passed.

Another recently licensed cable television operator, Total Access Communication (TAC) -- a fully-owned subsidiary of United Communications Industry Company (UCOM) -- also owns and operates a fiber optic network in Bangkok. TAC plans to transmit cable television signals via its existing 500-kilometer fiber optic network in Bangkok which serves and supports its current cellular service. TAC is planning to expand the network to 1,000 kilometers of fiber-optic cables. The expansion of the network is expected to cost approximately $80 million (2 billion Baht). To date, Nokia, NEC, Mitsui, General Instrument, and AT&T have submitted bids to expand TAC's current network.

On the cable TV provider side, a variety of powerful operators are likely to pressure Thai authorities to grant permission for their networks to be used for voice services. Shinawatra subsidiary IBC and Thai SkyCable have had the benefit of five years of experience in the subscription television market. IBC has benefitted from Shinawatra's marketing and economi might -- the company operates the Thaicom domestic satellite -- and given Shinawatra's pervasive influence in the telecoms sphere could well become a provider of local voice service in the future. IBC and ThaiSkyCable currently use multipoint, multichannel distribution system (MMDS) via UHF-band radio. Both companies have initiated the migration towards direct-to-home (DTH) service via Thaicom 1 Ku-band transponders.

Korea

With cable television services rolled out in March 1995, South Korea is one of Asia's most interesting and highly regulated CATV markets. Korea's CATV market is characterized by entrenched foreign suppliers and government-favored local manufacturers. The South Korean government began planning for the country's cable television industry in 1987. The introduction of cable television was scheduled for 1995, and was conceived as a stepping stone for multimedia services to be developed by the year 2010. Government plans call for cable television service to be provided to homes across the nation via a combination of fiber optic and coaxial cables. These facilities will eventually be upgraded to carry other services, such as voice and data.

Korea has one of the newest and most highly regulated CATV industries in Asia. The three network operators commissioned by the government to transmit cable television signals from program providers to cable TV system operators and then to the local curb are voice carriers Korea Telecom and

DACOM, and utility KEPCO (Korea Electric Power Co.). The first cable TV services in the country were cut over in March 1995.

Currently both Korea Telecom and DACOM already offer telephone service. At least initially, Korea Telecom is the only provider ready to offer CATV and telephony over the same network. KT is expected to transmit CATV signals to about 2.5 to 4 million Korean households on its new CATV network. In the short term, KT intends to use a satellite-based system to connect program providers to CATV operator headends and fiber optic cables at 450 MHz for distribution of programs to the homes. At present, KT is still undecided about the type of long-term cable television network to deploy. KT is currently interested in working towards the Information Superhighway project, which will incorporate video entertainment services -- DBS, cable television, and Video On Demand(VOD) -- with B-ISDN services by the year 2010.

DACOM has not yet completed its nationwide telephone network, let alone begun to offer CATV services. DACOM was licensed to provide CATV transmission service in four districts, including Kangnam, Seocho, Kangdong, and Songpa. DACOM's current activities in the CATV/broadcasting arena include a satellite news gathering network and an international TV transmission service. DACOM expects to provide subscribers high-definition TV service and other VAN services through star-configured trunk network using fiber optic and a tree & branch-configured distribution network using coaxial cables. To date, DACOM has not actively pursued this network plan and has no agreements with CATV program providers or system operators.

Cable TV provider KEPCO is currently prohibited from providing telephony transmission service. However, many expect that KEPCO will be allowed to serve as an alternative telephone service provider within five years, once it has demonstrated its technical and financial might. KEPCO is investing up to $40 million in the construction of a CATV network which will have more than ample capacity to accomodate voice and data services. As of December 1994, KEPCO had agreements with 32 system operators, who provide the to-the-subscriber portion of the CATV network. Subscriber levels could potentially reach 4 to 6.4 million. KEPCO expects to have fiber optic trunking cables at 750 Mhz and a combination of fiber optic cables at 750 Mhz and coax wires at 550 Mhz for the local loop.

Korea is also notable for its extensive plans for manufacturing CATV equipment locally. The government has implemented a policy encouraging network operators and system operators to purchase 85 percent of their equipment locally. Korea Electronics Technology Institute (KETI) was commissioned to ensure that the manufacture of CATV equipment and parts are localized. Korea's Ministry of Trade and Industry has also drafted the "Development Plan for Korean-type CATV" -- a 72-item list covering planned localized CATV equipment -- to encourage local production. Such policies thus limit foreign suppliers to participating in the Korean CATV market through technical licensing, non-binding alignments with local system integrators and distributors, or formal joint-ventures with indigenous companies.

Hong Kong

While still hampered by regulatory restrictions, Hong Kong is likely to become one of the primary testbeds for convergence services in Asia. Hong Kong's voice services market was recently opened to new operators, with New T&T, New World Telecom, and Hutchison Telecom stepping up to challenge primary carrier Hong Kong Telecom (HKT). The CATV market is limited to CATV provider Wharf Cable until the end of 1996, but other operators are already gearing up to step in once the market is opened.

Former monopoly voice carrier HKT is already beginning to provide broadband services; while banned from entering the CATV market until 1996, HKT has already begun building out a broadband network which will be more than capable of supporting both voice and CATV transmission. HKT began trialling video-on-demand (VOD) services in 1994. In September 1994, its technical trials of VOD began with fifty internal users, who were connected via Asymmetrical Digital Subscriber Line (ADSL) modems supplied by Westell. HKT then installed fiber-to-the-building for a second trial. HKT plans to launch commercial interactive multimedia services, including VOD, in mid-1996; it is currently tendering for a network platform supplier. By the second year after rollout, the service is expected to reach 200,000 homes. During the second phase of IMS implementation, HKT will request proposals on system integration and program management for the broadband network on which its service platform is built. HKT has earmarked $64 million for the VOD project.

Wharf Cable is moving in the opposite direction, with plans to use its CATV network to attract voice subscribers. Wharf's CATV license currently does not permit it to offer telephony services, and Wharf subsidiary New T&T is initially investing $770 million in a fiber optic network to compete with voice services provided by HKT and the other new carriers. However, it is expected that New T&T will ultimately be able to use Wharf's extensive CATV network as a platform for telephony and other broadband services.

Hutchison Telecom -- already a telecoms giant in Hong Kong -- and New World Telephone, a subsidiary of real estate giant New World Properties, have no CATV plans at present and are concentrating on the early stages of building out their voice networks which are to be cut over in 1995. Given the amount of investment planned by these two carriers, however, it is extremely unlikely that they will be content with providing voice services alone. New World is investing $256 million in its network, while Hutchison will spend $449 million initially. Both are building intelligent broadband networks capable of delivering a variety of services to the subscriber, and once Wharf's CATV monopoly runs out, they are expected to provide the full range of entertainment and interactive services.

Australia

Convergence has become a new battleground in Australia, on which Telecom Australia has pitted its broadband arsenal against that of rival Optus. Both companies are authorized to provide telephony and CATV services. Australia's telecom regulatory situation is designed to be technology neutral and encourage innovation and limited competition. Telstra has enlisted Rupert Murdoch's News Corporation to assist it in entering the cable TV market. Telstra is conducting a trial broadband CATV network project which will connect 50,000 homes. The company is using an ADSL-based distribution strategy for low-density areas, with Philips serving as the systems integrator.

For its part, Optus is working with allies Continental Cablevision, BellSouth, and Australia's Nine Network in its broadband convergence effort. Optus plans to invest $560 million over five years in network expansion, much of which will be directed toward the provision of CATV services. The carrier plans to roll out CATV service by year-end 1995, and to capture 70% of the market for pay TV and broadband services by 1998. Optus' network will be based on hybrid fiber-coax media, which will accomodate both voice and CATV; Scientific Atlanta is serving as the primary supplier.

VI. Future Directions

In conclusion, the convergence of cable television and telephony services will shape several trends in the development of Asia's telecom networks and regulatory environment. The integration of these and other services will require the consolidation of regulatory authorities, much as this may be resisted for political reasons. As technology advances, control of content will become increasingly difficult, posing potential dilemmas for countries such as China and Singapore, where politically and socially sensitive material is highly monitored. Lucrative entertainment services -- extending beyond cable TV to pay-per-view, video-on-demand, home shopping, etc. -- may accelerate telephone network expansion, especially in rural and remote areas, where obtaining sufficient revenue from providing voice service alone has been a consistent problem. Finally, the convergence of networks will also eventually lead to large-scale consolidation within the industry itself, as operators find it advantageous to team up, combining their expertise and network infrastructure.

References: The material discussed in this paper is based primarily on Pyramid Research's proprietary research, including several articles from the monthly newsletter, Pyramid Research Asia. Pyramid Research is a market research and consulting firm specializing in telecommunications markets in developing countries.

Converging Technologies: Towards Enterprise Integration

Dusan P. Jokanovic* Norio Shiratori* Kyosuke Moizumi**
* Tohoku University, Sendai, Japan
** Furukawa Electric Co., Ltd., Sendai, Japan

ABSTRACT

Concurrent engineering (CE) is an approach to product development that integrates a company's overall knowledge, resources, and experience as early as possible in the design cycle. Among many technologies that support CE, we consider two: teleconferencing, which enhances communication amongst geographically separated project team members, and intelligent computer-aided design/manufacturing (CAD/CAM), which enhances members' productivity. We show how these two technologies effectively combined enable conferencing over networks for on-line collaborative design.

For low-speed networks, we developed a CE method for exchanging and sharing product data that is fast, inexpensive, and compliant with the emerging STEP standard for product information representation. The method is based on efficient product modeling that reduces the amount of data transmitted. For high-speed networks, we proposed an advanced CE system architecture based on distributed intelligent agents embedded in CAD/CAM software. The system allows for fast automated design by fully exploiting the inherent parallelism in the product design process.

1. INTRODUCTION

Concurrent engineering reduces the time needed to get a product to market by allowing different groups of engineers to work in parallel on different design and manufacturing tasks. It assumes that engineers share complete, accurate and unambiguous product model definition. In addition, they have to be able to get updated the common product model after each modification made to it by any participating engineer even when they are scattered throughout a vast region.

One of the enabling technologies for concurrent engineering is groupware[1] or multi-user software. It focuses on using the computer to facilitate human interaction for problem solving and design in shared environments. In the direction of shared environments research has resulted in systems like Monet[2], MMConf[3], and Mermaid[4]. Unfortunately, most of these systems although advanced in capabilities do not scale up well with industrial-strength design projects. Briefly, the amount of information to be transmitted and processed in real time exceeds the standard equipment capabilities. Moreover, the groupware software packages are usually too sophisticated and huge (often providing video-conferencing service). The running of such software may itself take away a great part of system resources. Therefore, deploying existing groupware software over networks necessitates using broadband communication links which many of small-sized companies cannot afford. To integrate our remote facilities we set out to develop a robust, reasonably priced, standard-compliant method that enables review designs for huge amount of data in real time over narrow-band communication networks. Before, our design engineers reviewed their designs manually, by exchanging large engineering drawings sent through the mail. These noninteractive reviews often generated multiple iterations of changes before converging on a model acceptable to both design and manufacturing. Out of frustration with this process, particularly the multiple iterations, new interactive review techniques were sought.

We found solution in data collaboration system based on CAD/CAM software and teleconferencing. It comprises data conferencing software and data management software. The former provides services for sharing "live" documents across remote computers. The latter provides facilities for standard-compliant product modelling In case when communication bandwidth is less of a concern, we have considered an enhancement to our CE system. Therefore, we propose embedding intelligent software agents[5] into CAD/CAM software that collaborate over network.

The rest of the paper is as follows. In Section 2 we describe our teleconferencing method. In Section 3, concerning product data modelling, we give a brief explanation of STEP (STandard for the Exchange of Product Model)[6]. In Section 4, to facilitate data management, we propose a new extension to STEP by introducing a data structure called delta file. Finally, in Section 5 we describe our advanced multi-agent CE system.

2. TELECONFERENCING

One step towards reducing unnecessary design and review iterations has been made by development of the intelligent CAD/CAM software in which we integrated design rules generated from factory guidelines, designers' experience, and standards. Such software makes it possible to consider and solve manufacturing problems early in the design process. But there are enough instances, especially with complex and/or electrically sensitive designs, where manufacturability conflicts with the many physical, electrical, and/or mechanical constraints on the design. In the first instance, managing these tradeoffs is best done by project team members' conferencing.

To this end we have developed a data collaboration system by which we efficiently transmit engineering changes between remote development teams over the low-speed communication links (see Fig. 1). A conference is set up by the design location when conflicts are likely to occur. Suppose a layout designer has an initial placement of electronic components that he or she would like to validate with the factory that will assemble the bare board from the specified electronics components. The design location is typically the host station that drives the conference. The manufacturing location is the remote station that is simultaneously updated with the changes from the host station. In the preparation for the conference, the designer transfers a standard representation of the design to the manufacturing site. On the actual day of the conference, design and manufacturing both start up the conferencing software, initialize the design, and establish a session, connecting the host and remote stations. Next, both stations read in design data to be reviewed. At this point, the remote station will connect to the conference by entering a unique session identifier, which will route the incremental changes initiated by the host station across the network. The remote station than suspends itself, waiting for input from the host station. The host station must provide the machine name of remote station and the session identifier entered by the remote station. The conferencing software then sets up a link between the two machines. Both locations now see identical views of the design. As actions and changes are performed at the host station using the software, incremental changes are sent to the remote station. The latter reads them and updates the design database and the graphics screen, so that an identical session appears there. The design location first runs design-for-assembly audits; these check the placement of electronics and electrical devices against the assembly requirements and display the resulting manufacturing violations on both display screens. Next, the team checks against the violations and discusses the possible tradeoffs by speaker-phone. Design alternatives can be explored in real time, with manufacturing receiving immediate feedback of the changes made. The audits may be run either dynamically or in batches, to ensure that fixing one violation does not create another. The team can examine the design in detail by zooming in and out on different sections of the design or querying attributes of the board design features. Thanks to the real-time feedback and interactive nature of the conference, the team can quickly brainstorm and explore multiple design alternatives in rapid succession, avoiding many iterations and misinterpretations. To end the conference, the host and remote stations disconnect from the conference using the conferencing software. The system architecture supports conferencing over long distances via narrow-bandwidth networking mainly in two ways. It allows off-line transmission of a complete representation of the product model to the remote station prior to the conference. It also accommodates a stream of small application-specific messages for design updates sent from the host and received and acted on by the remote station. These two factors allow for fast real-time conferencing since there is no need to send massive amounts of low-level data such as screen images.

We have adopted minimalist approach to developing the conferencing software in that we emphasize the data collaboration and audio functionality, with a video being a complementary piece but not a requirement. We opted for data collaboration tools over video because these tools are lower priced, impact the network less and do not require hardware upgrades. Video-conferencing requires real-time, high bit-rate communication with low end-to-end delay something LANs are ill-equipped to deal with. Even with compression, most LANs today do not provide the bandwidth required for real-time communication because the bridging and routing devices on LAN internet can create bottlenecks for video traffic.

Data conferencing software is based on Novell's TSAPI (Telephony Services Application Programming Interface). It has a WINDOWS-based client library and a NetWare loadable module (NLM). We have taken advantage of its client library to write interface to our applications. The conferencing software uses a CTI(Computer Telephone Integration) server to access a PBX that connects to the other server or the PBX. This provides telephony service to users connected to the server or the PBX. The server-to-PBX link eliminates the need for additional hardware in each workstation so that any telephone set could be used at the desktop as a peripheral device. Our desktop data conferencing system allows workstation users to work simultaneously on an application, annotate documents using a whiteboard, transfer files and send messages.

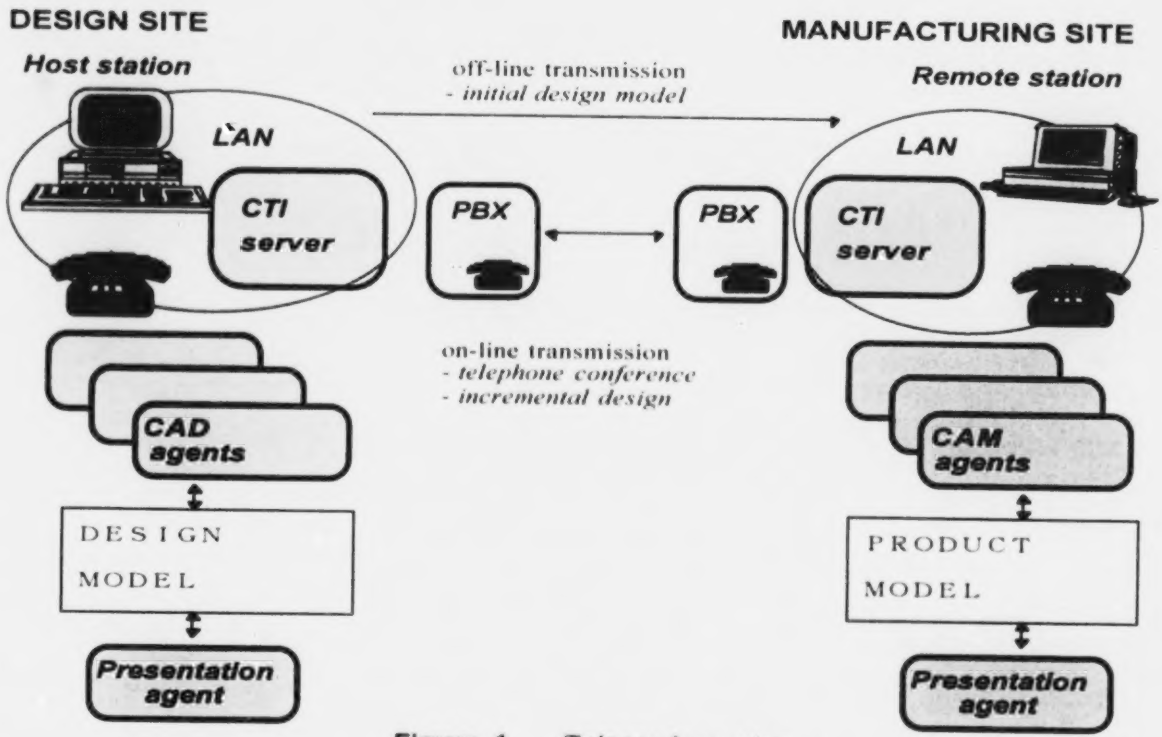
DESIGN SITE
Host station
LAN
CTI server
off-line transmission
- initial design model
MANUFACTURING SITE
Remote station
LAN
CTI server
PBX
PBX
on-line transmission
- telephone conference
- incremental design
CAD agents
CAM agents
DESIGN MODEL
PRODUCT MODEL
Presentation agent
Presentation agent

Figure 1 *Teleconferencing*

3. COMMON PRODUCT MODEL

A complete, compact representation of product-design model is one of the critical elements in the architecture since it provides a common initial state for the conference. The representation must be comprehensive yet manageable. On the one hand, it must provide a complete set of information for the product design, including the automated manufacturing design rules and violations. On the other, it must be small enough to be reliably transmitted over the existing network links. Our approach to meeting these requirements considers extending the STEP standard.

We have taken advantage of the ISO 10303 (STEP) standard is an international standard. It is a viable alternative to older IGES and DXF data exchanges formats that enable application interfaces between different application systems (e. g. CAD/CAM and databases.) It provides an unambiguous representation and an exchange mechanism for computer-interpretable product information throughout the lifecycle of a product. STEP is defined by EXPRESS [7], a language which allows for partitioning of the diverse materials in STEP. It is both human and machine readable as it enhances human understanding and generation of machine-interpretable applications. EXPRESS is an object-oriented data descriptive language which characterizes each entity by attributes, rules and constraints. It forms a hierarchical structure of classes in which subclasses inherit attributes, rules and constraints from their superclasses. Please notice that STEP is still under development. The available documents are continuously under review for modification. The STEP documentation is organized into document clusters. Two of them are of the special interest to us: documents on integrated resources and application protocols.

Integrated resources define a generic data structure for product information, and mainly consists of two parts: generic resources and application resources. The generic resources contain EXPRESS-defined entities which are independent of any application. An extension of generic resources is application resources which consist of entities related to specific applications. In the application resources, entities are constructed or referenced from the entities in the generic resources.

An application protocol defines the scope, context and information requirements of an application. Application software should be implemented in accordance with that application protocol to provide standard information structure. The product models in STEP use the application protocols to combine information models from the library of product information models. An information model is a mathematical description similar in intent to an entity relationship diagram, but more sophisticated because EXPRESS uses program-like notation to describe both the data structures for representing information and the constraints that instances of the information must obey. For example, STEP Part 42 is an information model describing the entities needed to define the geometry and topology of a product. It describes the data structures needed to represent many of the geometries that occur in CAD as well as the constraints that a set of geometric entity instances must obey in order to be topologically correct. An EXPRESS compiler translates the information model into a data model for a data management system. In our test system, we customized the C++ classes generated by our EXPRESS compiler. STEP facilitates concurrent engineering by providing a common definition for the data needed to populate product models. To implement concurrent engineering, all CAD/CAM systems used by CE teams must share a common product model, as shown in Figures 2 and 3.

In our test system we have been experimenting with two CAD/CAM systems: AutoCAD and Pro/ENGINEER. The AutoCAD software serves for part configuration design and electrical scheme modelling and simulations. The Pro/ENGINEER system is intended for design for manufacturing. A standard data interface called the STEP Data Access Interface (SDAI) specifies how information in an EXPRESS information model instance can be accessed from applications. SDAIs are used as wrappers to enable interoperability among different tools and applications. We made extensive use of SDAI when implementing test system as explained in the next section.

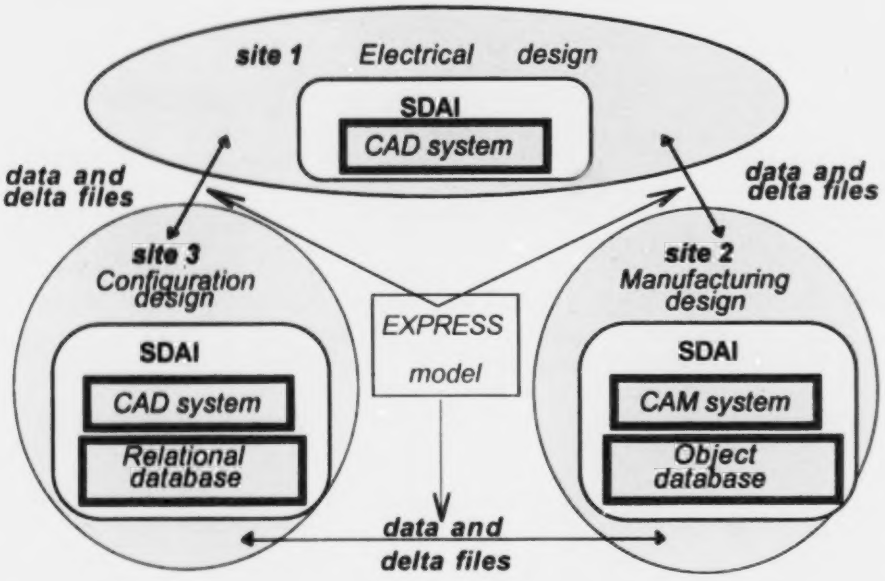

Figure 2 *Common Product Model in Distributed CE Environment*

4. DATA MANAGEMENT FOR ON-LINE COLLABORATION

Data management software, based on object-oriented technology and STEP enables product data modelling and extracting data changes during product evolution. It has been implemented in three stages. First we added SDAI interfaces to the AutoCAD and Pro/ENGINEER modelling systems. Second, we defined the extension for STEP in the form of delta files and implemented the tools to manage them. Third, we improved GUI by adding a tool to highlight the entities in Pro/ENGINEER database that are changed by a delta file.

Eventually, most CAD/CAM systems that create or process engineering product data will have an SDAI interface. However, because these interfaces are not currently available, we had to implement them for both modelling systems. Figure 3 illustrates the process we followed to add the SDAI interfaces to the CAD/CAM systems. We have used an EXPRESS compiler to compile the STEP Part 42 constructive solid geometry (CSG) model into C++ class definitions. We then used copies of the resulting C++ library to build the interfaces to AutoCAD and Pro/ENGINEER. This class library contains all the features necessary to define a mapping between EXPRESS and C++, all the methods needed to store a product model as a STEP file, and a rich set of methods to find the C++ object containing a particular STEP entity instance. We implemented the interfaces to AutoCAD and Pro/ENGINEER by adding methods to the C++ classes in the library. As for AutoCAD, these methods read appropriate instances from an AutoCAD database to produce a STEP product model for exchange with Pro/ENGINEER. As for Pro/ENGINEER, these methods write appropriate instances of STEP entities from an exchange file into a Pro/ENGINEER database.

As a part of version data control, we added a delta file mechanism to STEP. This required two extensions. The first let us add a unique and unambiguous identifier, the OID (Object IDentifier), to STEP entity instances. Please notice that the identifiers that STEP uses to identify entity instances in a Part 21 physical file are not unique across files. The second extension is an information model for engineering changes. The model describes an engineering change as a series of edits to the data instances in the product model. To expedite the development, we included only a minimal set of edit operators:

- *Edit Attribute* changes an attribute value in an entity instance,
- *Add Instance* adds an entity instance to a version of a product model, and
- *Remove Instance* removes an entity instance from a product model version.

Despite its simplicity, the information model can represent the difference between any two versions of a STEP product model. Figure 4 illustrates how it captures differences between two versions of a design. We have used three tools, based on similar UNIX tools, to capture and apply the changes described by a delta file:

- *diff* compares any two versions of a product model and generates delta file describing their differences,
- *sed* applies the edits in a delta file to the entity instances found in another version of a product model, and
- *conflict* finds low-level conflicts between a product version and a delta file or between two product versions.

Delta files capture only changes between successive product model versions. Therefore, they are considerably smaller than original complete design files, which make them convenient for transmission over standard narrow-bandwidth networks.

Eventually, to make our system more user friendly we modified system's GUI. To make the tool easier for all users to use, we added code to highlight entities on a graphic display when a record in a delta file indicates a change. Now, the knowledge of EXPRESS is not necessary to use the tool. For the test system we implemented this feature as a command line option in Pro/ENGINEER.

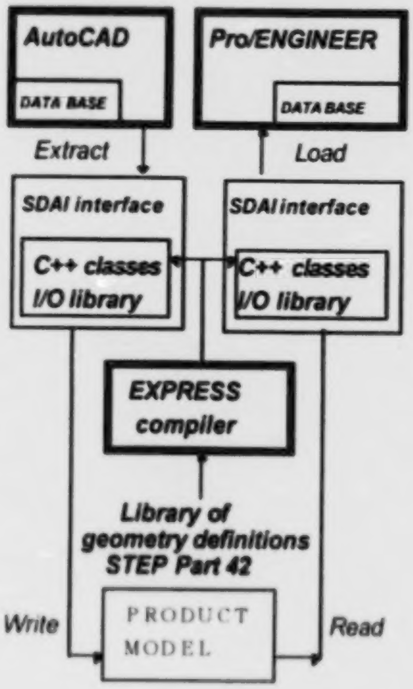

Figure 3 *Adding STEP interfaces to CAD*

The test system identifies several issues for the further consideration when using delta files for concurrent engineering. First, large product models may have many entities that are not relevant to a particular engineer and that the engineer therefore wishes to ignore. For example, a process engineer may only be interested in changes to project control information in a product definition and not care about differences in the geometry of the product. Second, data files can be used to build a change notification system for a group of engineers working on a design of product. If a base product model is changed to meet a new requirement, then the changes can be propagated to all other versions of product models derived from that base model.

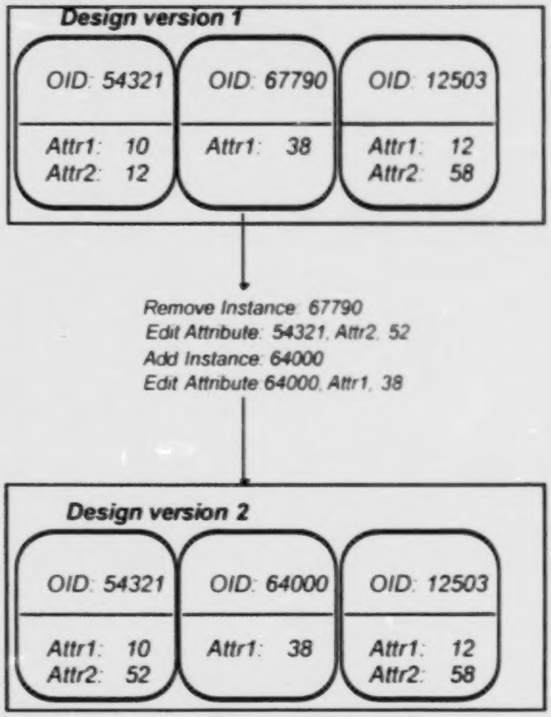

Figure 4 *Capturing differences between designs*

5. INTELLIGENT DISTRIBUTED AGENTS FOR AUTOMATED DESIGN

One of the advantages that our system for on-line collaboration poses is low communication cost. However, it best suits traditional design process, that is, point-by-point design: a single design is created and passed, in turn, to other project teams for modification. Each team in turn changes the design to meet its objective by creating another point in the design space. The weakness of this approach is that the design process might take long time to converge. One team might undo the changes introduced by another, which causes the first team to change the design again, and so forth. As explained in previous sections, our CE method accelerates the point-by-point approach by using common data representations based on STEP. Using common data representation increases communication speed by ensuring that no representation translation is needed. But although the method accelerates the design process, it does not fundamentally change it. Communication is not the only issue, however. An important principle behind CE is unleashing the inherent parallelism in the design process: transforming a serial design process to a parallel one. Such parallelism helps to identify design conflicts early, avoiding iterations that could arise in the serial approach. However, to fully exploit the inherent parallelism in the design process requires a radically different design approach and considerably broader network bandwidth.

In case when communication bandwidth is less of a concern, we have considered an enhancement to our data collaboration system. We propose embedding intelligent agents into CAD/CAM software that collaborate over network. An agent is a computational process with expertise about a limited portion of a design, analysis and manufacturing problem. These "smarter" CAD/CAM systems use the experience of expert engineers, designers, and manufacturers not only to find problems but to correct them. They also offer design advice, create designs independently, and assure parts meet standards across engineering disciplines.

The spectrum of applications for intelligent agents is very wide. In our test system we are concerned with configuration design where agents select and interconnect components from a catalog of parts to implement a set of functions. The system is a collection of loosely coupled, autonomous agents that organize synchronous communication among themselves based on high-level specifications that a designer provides for a desired design. Specifications include the functions to be performed, their interconnections, and performance specifications (bounds on cost, failure rate, and so on). Agents are distributed functionally and geographically, and communicate by passing messages so they can reside anywhere in the network.

Agents fall into four categories: *catalog*, *constraint*, *bid* and *system*. *Catalog agents* are electronic part catalogs that represent sets of physical parts. Components in part catalogs can be of virtually any complexity. The catalogs are derived from existing (paper) catalogs and from less structured sources, such as engineering notebooks and schematic drawings. The advanced system gives the designer a set of electronic catalogs that are always up-to-date. *Catalog agents* transform their catalog into an attribute-space representation, communicate their catalog to relevant *constraint agents*, and decide what parts to remove to satisfy constraint violations. *Constraint agents* represent feasibility constraints. They determine the set of consistent designs, identify sets of infeasible designs to remove, and define communication paths. The *bid agent* identifies undesirable designs from set of feasible designs. The *system agent* provides a graphical interface that captures the design specifications. It translates the specifications into the common representation, and broadcast them to all relevant agents. Then, it constructs so called virtual network for the current design, and verifies that the final design satisfies the specifications provided by the designer. (A virtual network is a specific set of constraint and catalog agents to solve design problem; it is a subset of all possible constraint and *catalog agents*.)

Our method is a distributed, automated synthesis approach that generates a space containing all possible complete designs, some of which may be infeasible. The design problem is formulated as a distributed, dynamic, interval constraint-satisfaction problem (DDICSP)[8], which is an amalgamation of problem solving and reasoning methods which have been researched in artificial intelligence (AI). Instead of reasoning over single designs (points in the design space), our system enables reasoning over attribute-space as a collection of intervals, where each interval corresponds to a part attribute. Agents use standard interval arithmetics[11] to evaluate constraints. They then narrow this space by simultaneously applying constraints and preferences until only feasible designs remain. They operate in a decentralized fashion, exploiting inherent parallelism in the design process, thereby speeding up the process while guaranteeing feasibility. The more detailed explanation of the method is out of scope of this paper and can be found elsewhere[9].

The multi-agent system architecture is shown in Figure 5. The crucial issue in such a system is the issue of agent coordination which include: locating agents, establishing and maintaining sessions among them, synchronizing agents, detecting their failures and recovering them from failures. This is resolved in the system coordination layer by the enhanced client-server paradigm[10]. Please note that the *catalog agent* is fundamentally a communication wrapper placed around a part catalog. The communication wrapper provides an interoperable interface to other agents. This interface defines the protocol that the system uses to solve a design problem.

The automated configuration design is now being applied to large-scale engineering project. Designers role is only to input configuration specifications and the system finds out optimal design regarding one or more criteria. The system enables configuration designers to have an easy access to a wide variety of part catalogs from many different vendors, without need to know who or where those vendors are. By considering parts from a variety of sources, our system can generate high-quality, low-cost configuration designs.

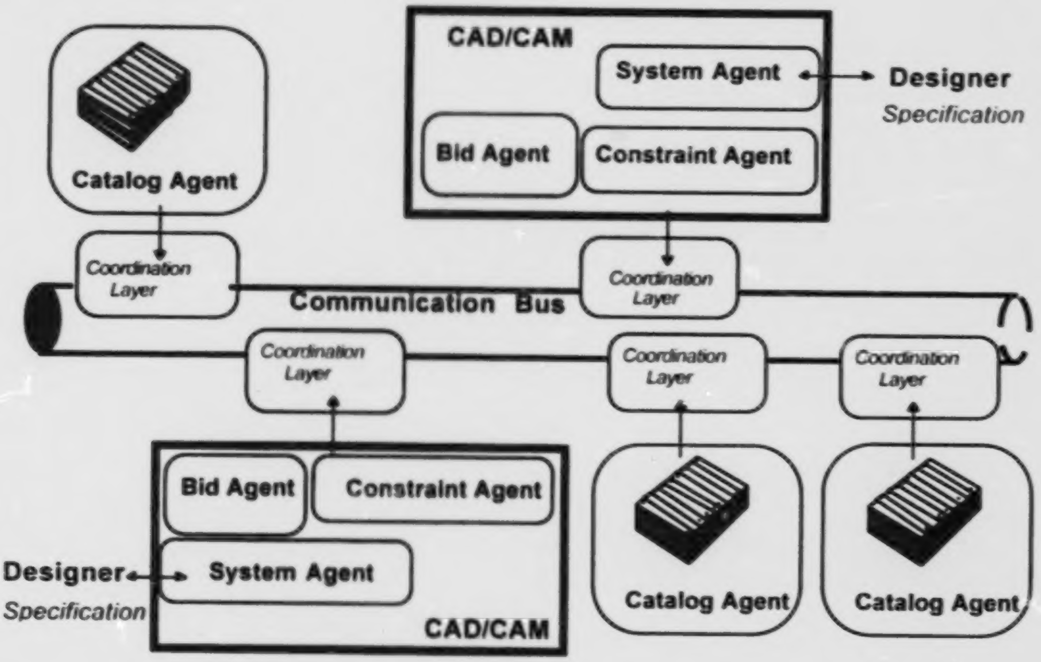
CAD/CAM
System Agent
Designer
Specification
Bid Agent
Constraint Agent
Catalog Agent
Coordination Layer
Communication Bus
Coordination Layer
Coordination Layer
Coordination Layer
Coordination Layer
Bid Agent
Constraint Agent
Designer
Specification
System Agent
CAD/CAM
Catalog Agent
Catalog Agent

Figure 5 *Multi-agent architecture for automated configuration design*

Also, electronic communication of component data can deliver a far greater range of information to a designer than it was possible. A distributed architecture also let each vendor maintain its *catalog agent* at its local site. Changes or additions to the part catalogs can be made locally, and be immediately available to all users over the network. The system lets vendors join the network without knowledge who or where the client designers are. This lets a new vendor become known to a large population of prospective clients.

6. CONCLUSION

Design expertise for a complex artifact is very often distributed among different groups, and might be geographically dispersed in a single company or multiple companies. The advances in telecommunication, artificial intelligence and CAD/CAM technologies allow for firmer enterprise integration despite such a situation. To this end we proposed two concurrent engineering methods. For low-speed networks, we developed a method for on-line data collaboration that is fast and inexpensive. In addition, it uses common product model, which is compliant with the STEP standard. For high-speed networks, we proposed a method for automated configuration design based on distributed intelligent agents.

As for the former method, according to field trials conducted to get user's response the participants feel satisfied. First, they can conference in their own departments and time frame--a welcome flexibility, given the hectic pace of design and manufacturing. Second, there existing hardware, software, and networking suffices--there is no need for expensive high-bandwidth links or new hardware devices. Third, the design interval has been shrunk and many iterations are avoided. Fourth, since the conferencing mechanism is built into the software, the participants are not bothered by an additional conferencing apparatus, other than at the start and end of the conference. They can therefore focus their full attention on the problem at hand. Finally, the participants report that the dynamic communication through the conferences raised the level of teamwork between design and manufacture. A new level of ownership for the design and the resulting tradeoffs has also been created. Furthermore, for a design review of the type portrayed, this way of conferencing is less costly than the typical teleconferencing available today.

However, even though common product model and teleconferencing let all designs concerns participate early in the design, the problem remains that each participant changes the design to satisfy constraints and preferences from its perspective, without regard to how its decision will affect others. This causes needless iterations. Expansion to hundreds of components and constraints and many interested participants from different documents (marketing, finance, and so on) compounds the problem. To cope with the problem, we proposed a system based on intelligent software agents. Adding intelligence to system may improve its functionality in various aspects. For example, we conjured up collaborating agents that generate a space containing all possible complete product designs, some of which may be infeasible. They then narrow this space by simultaneously applying constraints and preferences until only feasible designs remain. The system operates in a decentralized fashion, exploiting inherent parallelism in the design process, thereby speeding up the process while guaranteeing feasibility.. In addition, we envision the other applications for intelligent agents that somehow upgrade on-line collaboration such as ones that coordinate engineering changes, manage delta files, and notify users when critical values change.

REFERENCES:

[1] C. Ellis, S. Gibbs, and G. Rein, " Groupware: Some Issues and Experiences." Communications of ACM, Vol. 34, No. 1, Jan. 1991.

[2] K. Srinvas et al., "Monet: A Multimedia System for Conferencing and Application Sharing" Proc. First Workshop on Enabling Technologies Group, CERC, West Va. University, Morgantown.

[3] T. Crowley et al., "MMConf: An Infrastructure for Building Shared Multimedia Applications." Proc. ACM CSCW 90, ACM Press, New York, 1990.

[4] K. Watabe et al., " A Distributed Multiparty Desktop Conferencing System," Proc. ACM CSCW 90, ACM Press, New Yourk, 1990.

[5] *Industrial Automation Systems--Products Data Representation and Exchange*: Draft International Standard 10303-11, ISO, Geneva, Switzerland, 1992.

[6] C. Guilfoyle and E. Warner, *Intelligent Agents: the New Revolution in Software*,Ovum Limited, London, UK, May 1994.

[7] D.A Schenck and P.R. Wilson, *Information Modelling the Express Way*, Oxford Univ. Press, New York, 1994.

[8] M.Yokoo et al., "Distributed Constraint Satisfaction for Formalizing Problem Solving," Proc. 12th Int'l Conf. Distributed Computing Systems, IEE Computer Society Press, Los Alamitos, 1992.

[9] D. Jokanovic, "A Multiagent System for Automated Design and Manufacturing," Technical Report No 95-89 Furukawa Electric Co. June 1995.

[10] R. Adler, "Distributed Coordination Models for Client/Server Computing," IEEE Computer, Vol. 28, No.6, April 1995.

[11] E. Hyvonen, " Constraint Reasoning Based on Interval Arithmetic," Artificial Intelligence, Vol. 58, No. 1-3, Dec. 1992.

The Development of Interactive Multimedia Services (IMS)

Samantha Hon
Hongkong Telecom, Hong Kong

On top of technology advancement, the development of Interactive Multimedia Services (IMS) will be affected by four major factors: demand for IMS, initiatives by business corporations to provide IMS, macro environment and regulatory framework. This paper examines the status and the outlook for these four factors.

We are entering into an era of electronic information where people can access the required information, entertainment and services easily with TV or PC.

The major benefits to customers is one of convenience. To businesses IMS provides an economical and direct means to reach their customers.

To turn the theory into practice, four enabling factors need to be satisfied:

A) Market demand for IMS
B) Initiatives by business corporations
C) Favorable macro environment
D) Adaptable regulatory framework.

(A) Market Demand for IMS[1]

IMS allow users to retrieve, process or transmit video, audio and data on a point-to-point or one-to-one basis. IMS is made possible by the convergence of technologies. Shopping, entertainment, banking, education and a host of other services can be accessed from the office computer, the home television or even when you are on the move.

There are many estimations on the market potential of IMS. The most recent development of Internet can be used as a reference in estimating the potential of interactive multimedia services.

As the technology developed, the current text and graphics oriented wet site furnishing will be enriched with audio and video in the longer run. The demand on web illustrates the potential of online interactive business development. Web allows user to access documents that have been linked across the Internet. It does not require the user to learn a lot of commands. You can jump across difficult documents just by reading the text or images and select the items that you wish to view. Internet has been in place for 25 years but the major growth occurs in the last three years due to the development of Web and the graphical browsers such as Mosaic and Netscape. It is estimated that today there are over 23,000 Web hosts worldwide, more than 178 times of the count in 1993 and the number of Web hosts is doubling every 55 days.

The global reach and the variety of readily available content enable web to reach the critical mass quickly. It is estimated that there are 20 - 30 million people using Internet (Netscape reports an average of 15 million hits per day). The demographics of these users, who are predominantly young, middle to upper class, well-educated and highly motivated attract the "gold rush" over the Internet by commercial organizations.

Further, there are 6 million online users who spend around 2 hours online per week. The major service providers are American Online, CompuServe and Prodigy.

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[1] "Designing Electronic Catalogues for Business Value", Oct 1995, CommerceNet

As various applications developed, content providers will enrich the content with audio and video and people will demand more and more bandwidth. The current development on Internet will establish a solid foundation for the growth of the long term broadband multimedia network.

(B) Initiatives by Business Corporations

The rapid development of applications over Internet are driven by the strong motivation of the companies to:

Maximize Market Exposure

Providing information to customer anytime when they want without requiring the customers to have any prior knowledge or contact with the company, Web site enables the companies to widen their exposure beyond their normal communications sphere.

Many companies use Web site to :

- advertise their service, products or promotion programs
- communicate press release, vision, mission, corporate structure
- outline corporate structure
- provide product information (product listing and brochure)
- present geographical coverage and office locations
- place vacancy notice for recruitment

Stimulate Sales Lead

Riding on the curiosity of users to check for information through Web, merchants stimulate sales leads by :

- ensuring that the catalogue are available anytime online (flower, books, gifts etc.)
- making online transaction easy
- providing promotional programs tailor-made for the online users
- accepting on-line request for quotation, products and services
- registering the customers who show interests in knowing more

Customers can place order at their convenient time even when they have missed the opening hours of the retail outlet or sales offices. The new media enable companies to extend its reach to the untapped market and capture the potential of impulsive and convenient buying as well as educated purchase.

Reduce Costs and Time to Information and Service Delivery

Online access facilitates the evolution of information publishing and process re-engineering and results in time and costs saving :

Information Publishing

Providing information on-line can substantially reduce the costs and time of publishing and distribution. Before using on-line services, companies produce catalogue, product literature, annual reports etc. in large quantity by estimating the potential demand and the copies have to be shipped to outlet locations to facilitate customer access. Further, whenever there is any change in information, the old version printout will either be abolished or require labor work to make amendment. After making decision on changes of information, it often takes weeks or months for the new version of printout to be available to customers.

In the era of electronic information, companies can substantially reduce the quantity of hardcopy and ship out printout only when they are requested by customers. Some companies even simply cease printing certain types of literature and use online as the prime information provision platform. More importantly, any changes in information can be made quickly on the electronic files and publish online within hours without incurring wastage of printout material. Customers can always get the latest updated information online.

Process Re-engineering

Computerization is an important process in enhancing efficiency and effectiveness of business operations. In the past, companies employ sales persons to answer questions from customers. In the last few years, interactive voice response system have been widely used by companies to facilitate information provision and business operation (e.g., phone banking). The logic behind the development is that a lot of the operation are repetitive in nature and, therefore, can easily be handled by machine. Web/online services will further extend the potential of computerization by enhancing the human machine interface and increasing the volume of information flow : provide text and graphics of information for users to read and allow users to key in the user information or request. For example, Cisco is offering technical support online through Internet. The development will accelerate the trend of computerization in certain areas of sales, marketing and customer services

Lock in Customer

In a competitive environment, companies need to stay close with their customers to know their needs, response to their request and provide services. Using online or Web site is just like opening a mini sales or customer service centre at the desktop of the customers, allowing them to access services at their finger tips. Further, companies can also use online services to :

- collect customer feedback, process and analyze customers needs to compile valuable marketing intelligence

47

- conduct target marketing, offers tailor made products and services
- address any potential threats and opportunities quickly by adjusting pricing, providing new service packaging and offering target or time specific promotion.

(C) Favorable Macro Environment

The Environment in which IMS operates will be crucial in determining IMS business. Different environment may have different enabling factors. For example, we see the following factors contributing to the IMS development in Hong Kong:

1. High Households Density

Being one of the most densely populated city in the world, Hong Kong has a households of 6 million people living on its 1,000 square km. Ninety percent of people in Hong Kong are living on high rises where there are, on the average, 174 homes per building. This environment enables us to enjoy the lowest network costs in the world.

2. Advanced Telecommunications Infrastructure

Hong Kong is the first city in the world to have a 100% digitized network. This provides a solid backbone for us to upgrade the infrastructure to a broadband network. Further, more than 85% of the high rise buildings are within 5 km of one of our 83 exchanges, ensuring minimum incremental costs and time required in rolling out the service to target areas.

3.. Affluent Customers

Enjoying the low tax rate, Hong Kong people spend more than two times on entertainment than people in other major cities or countries (e.g., US, Japan, UK, etc.). The GAP growth in China and other major development areas in Asia is around 10% while that in the State and Europe is just around 2%. Hong Kong is playing the role of regional hub and professional resource centre for the region and share the prosperity of the region. The economic well-being will provide a solid foundation for various IMS development.

4. Track Record in Adopting High Technology Products

Hong Kong has proven track record in adopting the latest technology for entertainment and personal convenience. For example, it has the highest laser disc player penetration in the world (it is 45% in Hong Kong, 12% in Japan, 6% in US and 2% in UK). Other examples include the popularity of mobile phones, pager and new car models. We believe that Hong Kong people will appreciate the importance of convenience and use IMS to enhance the quality of their busy lifestyle.

5. Opportunities for Target Marketing

In Hong Kong, direct marketing is still in its embryonic stage. From merchant's point of view, the only major communication channel is mass media: free terrestrial TV, radio, magazines, newspaper, etc. There is a strong demand from the merchants side to access the target customer group and to communicate tailor-made customer specific messages. IMS will, with its database on customer demographic data and spending behavior, fill the gap and become a major platform for target marketing.

48

(D) Regulatory Framework

The market structure of the IMS will be composed of a limited number of fixed telecommunications network licensee as the transport service providers and a number of individual or collective content providers operating in a competitive environment.

Based on the perceived impact of IMS on the community and form research of various regulatory models, we see that it is very important for the regulatory framework to fulfill the following guiding principles :-

1. **Positive**
   That the regulatory framework should encourage the private sector to take initiatives to develop services for the community, and to build an information superhighway which will strengthen commercial and communication activities.

2. **Flexible**
   That the regulatory framework should provide room for technology advancements which are accelerating everyday.

3. **Pro-competition**
   That the regulatory framework should encourage open competition

4. **Simple**
   That the rules and regulations should be easy for the private sector and the community to follow and that the cost of administrative overheads should be kept to a minimum.

5. **Built on Existing Legislations**
   So that consistency can be maintained and that new services to the community need not be delayed by the lengthy process of legislation.

Conclusions

The development in information superhighway will enable the whole community to become more efficient and effective. End users and various business organizations will benefit from the development. I would like to use the conclusion of the Group of 7 (G-7) Summit, which included France, Canada, Italy, US, Germany, Japan and UK, held in Russell on 24-26 Feb. 1995 on "Global Information Society", to wrap up this speech. It says :-

"Progress in information technologies and communication is changing the way we live, how we work and do business, how we educate our children, study and do research, train ourselves, and how we are entertained. The information society is not only affecting the way people interact but it is also requiring the traditional organizational structures to be more flexible, more participatory and more decentralized."

MMDS: A Low-Cost Infrastructure for Video, Voice, and Data

Bruce Carruthers, Steve Czarnecki, George Mandanis
SMG North America
San Francisco, United States

ABSTRACT

This paper examines the relative costs, performance attributes, and deployment advantages of wireless cable vis-à-vis alternative wireline, wireless, and hybrid network infrastructures designed to integrate the offering of video, fixed telephony, and data services within a local market. The paper focuses on the use of wireless cable for the creation of new networks to support a wide range of services.

INTRODUCTION

"Wireless cable" video service began in the United States in the early 1970s as a single-microwave-channel service authorized by the Federal Communications Commission (FCC) for the distribution of pay TV movies to hotel rooms. In an attempt to prevent the service from languishing and to promote competition to cable TV, the FCC, in the early 1980s, authorized additional channels and combined other channels to create Multichannel Multipoint Distribution Service (MMDS). Still, the business suffered from regulatory barriers and the resulting failure to attract serious, reputable investors. In fact, by 1989, U.S. MMDS had only a handful of subscribers; in the ensuing six years, however, subscribership has grown to 750,000. Elsewhere in the world, MMDS growth did not begin to take off until 1991. Currently, there are four million subscribers worldwide, and by 1997, that number is expected to quadruple. The equipment market, today worth $4 billion, will grow to $14 billion within the same period. The principal reasons for deploying these systems are the ease of installation and the relative low cost for both installation and maintenance. Figure 1 defines the various technologies for video distribution. Figure 2 (next page) compares the costs of deploying new video systems using various technologies.

CURRENT STATUS OF MMDS

MMDS systems have been deployed in 69 countries, reaching about 150 million line-of-sight homes. The strategies of the MMDS operators as well as the locales in which they operate vary widely, but the low cost of deployment is universally appealing and is a principal growth driver. Some 290 systems are in operation worldwide in locations such as Mexico, Mozambique, Iceland, Australia, the Commonwealth of Independent States (CIS), and throughout the United States. For example, MVS-Multivision SA de CV in Mexico City, one of the largest MMDS operators, currently serves 450,000 subscribers. Australia's Media (a direct-to-

FIGURE 1. Competing technologies for video distribution

Technology	Description
Old cable	Coaxial-cable-only network using analog technology
Upgraded cable	Hybrid network using fiber cable to connect local nodes from which subscribers are served by coaxial cable
DBS	Direct broadcast satellite system using geostationary satellites and 18"-diameter subscriber dishes
ADSL	Asymmetric digital subscriber line—electronic enhancement to telephone twisted-pair copper loop
Wireless cable	MMDS and LMDS (Local Multipoint Distribution Service)

FIGURE 2. Average U.S. investment cost per subscriber, video service only (U.S. dollars)

	Cell transmitter[1]	Distribution network[2]	Subscriber equipment and antenna[2] *Analog*	*Digital*	Installation[2]	Total[2]
Cable[3]	0	667	200	350	175	1,042–1,192
MMDS	~30	0	350	450	175	555–655
LMDS	~30	0	400	500	175	605–705
DBS	Earth station	Satellite	N/A	700	225	925

[1] Per home passed or seen; [2] per home served; [3] at 60 percent penetration of homes passed by cable

home licensee) has 542 Australian franchises and is building rapidly. TVA, the pay-TV unit of Grupo Abril in Brazil, believes that MMDS will have 30 percent of Brazil's overall TV market by 2005. In the United States, Pacific Telesis became the first major telephone company to offer wireless cable television service via its acquisition of Cross Country Wireless, Inc., and recently acquired systems owned by Canadian-based Videotron that will extend its reach to nine million line-of-sight homes. Bell Atlantic and Nynex have invested in CAI Wireless Systems, Inc., which serves areas of the East Coast. And together, Pacific Telesis, Bell Atlantic, and Nynex formed TELE-TV, a venture that will develop programming services to be offered via MMDS systems to customers in each of their service areas.

Some operators, including those planning to reach potential markets using combinations of MMDS, cable TV, and DBS, believe that MMDS will be only an interim technology, chiefly because of the limitations of channel capacity and propagation characteristics. Others believe that MMDS will overcome its limitations and continue to be a viable and profitable video technology. Bell Atlantic and Nynex indicate that MMDS may well be an "interim" technology, but the interim may last for 15 years. In addition, the president of MVS-Multivision has said that MMDS as a video medium will be important in Latin America for the next 10 to 20 years; he also believes that distinct market niches may be appropriate for MMDS, cable TV, and satellite indefinitely.

Indeed, at the rate MMDS technology is evolving, it may become a widespread, permanent feature of the landscape:

- Digital compression technology is in the commercial testing stage.
- Antennas with built-in decoders are being tested.
- Research and development (R&D) efforts are being focused on minimizing line-of-sight limitations and developing interactive capability.
- Associations are actively funding R&D, including the development of standards.

Even analog systems will continue to grow for some time; U.S. operators indicate that analog systems are economically viable at a household penetration rate of only 10 percent. Figure 3 (next page) details performance characteristics of several alternative technologies, demonstrating the relatively favorable position of MMDS.

BEYOND VIDEO

Thus far, the proliferation of new and expanding wireless cable systems has involved video services only. But these systems also have the potential to become a low-cost, integrated medium for providing voice and data, as well. Figure 4 (next page) shows the costs of combining telephony and data with video in an MMDS network designed from the start as an integrated infrastructure. For the purposes of comparison, Figure 4 also shows the costs of adding on telephony to preexisting cable TV systems (old coax and upgraded cable). Only 10 percent of subscribers in the United States are served by upgraded cable; thus, even treating the investment in existing cable TV systems as sunk, a completely new MMDS system is, more often than not, less costly than

FIGURE 3. Performance comparisons

	Potential number of video channels[4]	Current/ feasible area coverage[5]	Signal quality	Local programming capability	Potential for interactive services	Maintenance requirements	Service reliability
Old coax cable	~50	80/0[6]	Poor	Yes	Limited[7]	High	Low
Upgraded coax cable	300+	10/90	Excellent	Yes	Yes	Moderate	Medium
DBS	200	2/80	Excellent	No	Limited[7]	Low	High
ADSL	1 to 4[8]	0/100	Fair	Yes	Yes	Moderate	High
Wireless cable	300+	~1/~80	Excellent	Yes	Yes	Low	High

[4] Based on U.S. frequency allocations; [5] percentage of U.S. households; "accessible" is defined as being technically and operationally feasible, ignoring economics and market factors; [6] old cable will eventually be replaced by upgraded cable; [7] upstream via alternative path; [8] switched

the incremental investment needed to add telephony to preexisting cable.

Figure 5 (next page) is a generalized network diagram for interactive MMDS. The concept of an interactive configuration is beginning to catch on in a number of areas. In the CIS, Metromedia International Telecommunications has chosen to deploy wireless cable for telephony because of its low cost. Also, a British cable TV operator—EuroBell—intends to deploy MMDS in two rural areas, offering both telephony and video.

For the areas of the world in which the telephony infrastructure is primitive or, in some cases, nonexistent, MMDS can be a quick, simple, cost-effective solution. Despite the thousands of words written about "anywhere, anytime" communications, the information superhighway, low earth-orbit satellites (LEOs), and so on, the number of telephone lines per person varies enormously from place to place. For example, according to 1993 statistics of the International Telecommunications Union (ITU), selected teledensity (telephone lines per 100 persons) in areas of particular interest to PTC '96 are as follows: six in Brazil, 10 in Indonesia, and 56 in the United States. Worldwide, teledensity varies similarly by continent: 3.9 in Asia, 14 in the CIS, 15 in Africa, 26 in the Americas, 32 in Europe, and 37 in Oceania.

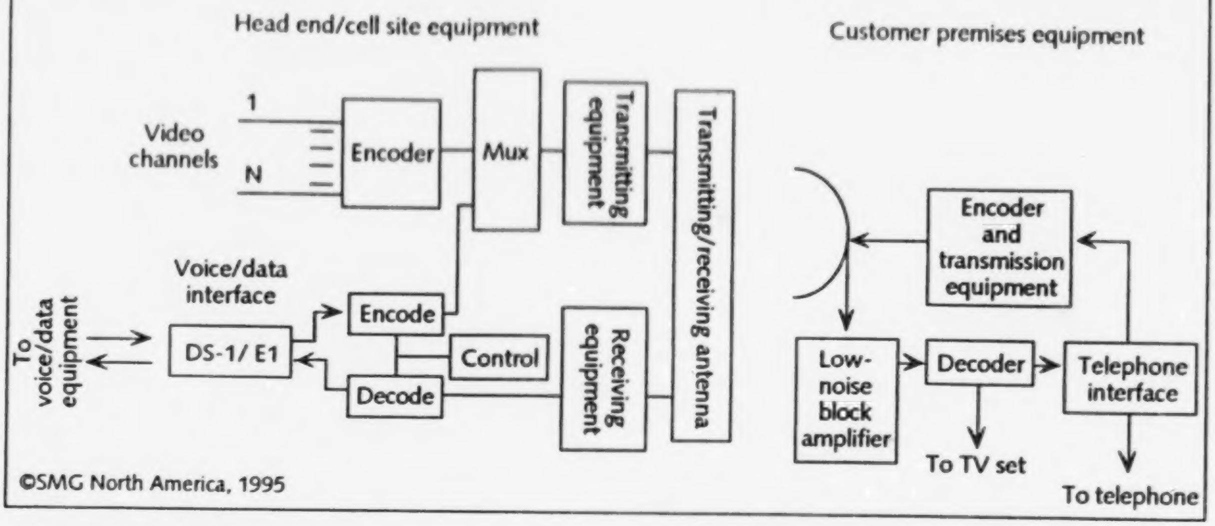
The resources required to bring dialtone to underserved areas cause continuing concern among agencies involved with funding modernization. Fixed wireless (other than MMDS) and cellular solutions are being licensed and deployed in a number of these areas, but none of these carry the advantages of MMDS, which

FIGURE 4. Investment cost[9] per subscriber for combining telephony and data with video (U.S. dollars)

	Receiver, switch, and backbone[10]	Subscriber equipment[10]	Installation[10]	Cable upgrade[10]	Total[10]
Integrated MMDS system	125	525	175	N/A	825
Upgraded cable (preexisting)	125	375	175	0	675
Old coax cable (preexisting)	125	375	175	375[11]	1,050
LMDS	125	575	175	N/A	875

[9] Based on U.S. costs; [10] per home served; [11] upgrade of all coax plant to fiber/coax at $225 per home passed with 60 percent penetration

FIGURE 5. Generalized interactive configuration


Head end/cell site equipment
Customer premises equipment
Video channels
1
N
Encoder
Mux
Transmitting equipment
Transmitting/receiving antenna
Voice/data interface
To voice/data equipment
DS-1/ E1
Encode
Control
Decode
Receiving equipment
Encoder and transmission equipment
Low-noise block amplifier
Decoder
Telephone interface
To TV set
To telephone

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can provide a "pop-up" telephone network quickly and cheaply in combination with video distribution.

SPECTRUM ALLOCATION

Even though licensing and spectrum issues, as well as technical issues, have limited the growth and full potential of MMDS up to this point, frequency allocation is moving ahead:

- The U.S. standard, 2.5–2.7 GHz, has turned out to be the one deployed most often worldwide; widespread deployment of one standard helps bring down the cost of equipment. In addition, fewer repeaters are needed at this low frequency, and digitization can enable frequency sharing in locations where these frequencies are occupied (mainly for government and military use).
- Twelve-GHz systems are being implemented in some areas not amenable to good transmission at the lower frequency, e.g., in the Arabian Gulf and Hong Kong.
- Forty-GHz frequencies have been allocated by the UK for wireless video service; in addition, CEPT has recommended 40.5–42.5 GHz for European systems.

A video trial at 28 GHz is in progress in the United States for LMDS, and a video system at this frequency has already been deployed in Caracas. Also, licenses at 38 GHz in 35 principal U.S. cities have been awarded to WinStar, which will provide local access service for long-distance companies, competitive-access providers (CAPs), and mobile (cellular and PCS) operators.

In general, regulators of spectrum worldwide are showing greater interest in authorizing and promoting wireless video in the conventional mode, but the real benefits may derive from combining video and telephony. Thus far, few authorities or operators seem to have considered it. For underdeveloped areas, it may be the best choice. And for areas of the world in which adequate or even sophisticated infrastructure exists and in which competitors in both telephony and video are increasingly active, MMDS may still offer great potential. The fact that some of the U.S. Bell operating companies and other entities having relatively sophisticated infrastructures already deployed are investing in MMDS may indicate that it can be the system of choice for a variety of integrated applications.

SUMMARY

The overall advantages of MMDS for offering integrated services are the following:

- Favorable investment costs and performance attributes for video distribution vis-à-vis cable TV and DBS
- Capability to support a low-cost fixed wireless

approach for interexchange (long distance) access and local exchange service

- Rapid deployment potential—no need for staged infrastructure build out
- Capability to accommodate a wide range of subscriber densities via straight-forward frequency reuse
- Engineerability to grades of service equal to, or better than, those of the telephone industry
- Less complexity and lower cost than PCS or digital cellular because fixed subscriber antennas and higher transmission power can be used and no cell-to-cell handoff is needed
- Capability to leverage technologies already developed for PCS and digital cellular
- Favorable risk and cash-flow structure for video and telephone investment since the principal investments are made only as subscriber demand materializes
- Broad market coverage facilitated by beam benders and digitization
- Capability to provide local programming (versus DBS)
- Capability to leverage technological developments already underwritten by cable TV and DBS
- Capability to implement interactivity cheaper and faster than cable TV.

Given this long list of advantages, MMDS would appear to be a compelling choice for an integrated telecommunication system in the 80 percent of the world that is currently underserved.

Pacific Islands Business Network (PIBN): Marketing Oceania Overseas

James Di Giambattista, Ph.D.
Pacific Islands Development Program
East-West Center
Honolulu, Hawaii, USA

ABSTRACT

The Pacific Islands Business Network (PIBN) is an online database service designed to serve the needs of business-to-business communication among producers of goods and services in the Pacific Islands and their mainland counterparts. By registering these geographically remote businesses and their products in specific detail on the Internet, it seeks to bring them into a wider sphere of commercial exchange. The PIBN includes significant background information on the details of doing business or investing in the Pacific Islands in the form of a virtual electronic library.

In October 1992, the Pacific Islands Development Program at the East-West Center began studying the feasability of an on-line information service to foster the sharing of basic government published information among Pacific Islands states and other Internet Users. The flow of indigenously published information from the Pacific Islands states to the rest of the world is sparse, and bears comparison with the flow of information from such underdeveloped regions as West Africa. There are several reasons that information flow out of individual Pacific Islands states is poor.

Information Dissemination in the Pacific Islands Region

Historically, it is only within the past thirty years that the metropolitan powers in the Pacific - Australia, the US, New Zealand, and Great Britain - have largely withdrawn from direct involvement in the affairs of the Pacific Islands states. The first independent state in the Pacific (aside from Tonga, which has always been independent) was Western Samoa, which became self-governing in 1962. The most newly independent state is Palau, which gained independence with the ending of the US Trust Territory agreement in 1992.

As the metropolitan powers have turned over the keys of government to native administrations, the public information and publishing functions of individual governments often underwent significant changes. Colonial administrations were geared to publishing government information on a highly regular schedule and distributing it within the island state, to authorities in the colonial motherland, and elsewhere abroad. Native administrations which followed often saw publishing primarily as means for one branch or program of the government to inform other areas of government about their activities and plans. In short, the newly independent island nations often overlooked the external importance of their publishing functions, and concentrated on the internal publishing and circulation of documents.

It must be clearly understood that this was not an attempt to limit the knowledge of citizens about their governments, but a different cultural understanding by the indigenous peoples of the public information functions of government. The pattern also does not fit every government in the Pacific. There were exceptions. The Solomon Islands, for example, followed through on the distribution of government information in the wider pattern established the previous colonial administration.

The Pacific Islands Development Program and the Principal Investigator began examining what, if anything, had been lost by this change in the distribution of government-published information by Pacific Islands states. While persons located outside the Pacific Islands often look at the Oceania region as a whole, the current flow of information from individual Pacific Islands nations is generally sparse and limited to a few offices in the former metropolitan power responsible for governance during the colonial period.

Present links between the Pacific Islands states and the metropolitan powers in the region primarily involve trade, economic assistance, migration of islanders, and inter-government cooperation. These links are of tremendous economic, political, and social importance to Islanders, but none of them are organized informational links. At the same time, there is a growing regional identity among Pacific Islands states and peoples. On the level of government, a growing cadre of leaders and bureaucrats from different states work together in regional organizations like the South Pacific Forum, and the regional bodies of international organizations like the United Nations Development Programme, the European Economic Community mission to the Pacific, and the South Pacific Regional Environmental Program. There also is slow but steady progress in the growth of intra-regional trade in some speciality agricultural commodities and manufactured products.

The Pacific Islands Business Network

An initial goal of the Pacific Islands Business Network (PIBN) was to create a virtual electronic library and provide users with on-line access to the core of government information relevant to devising new laws, trade, investment, and economic development policies in the Pacific Islands region. The object of the database was to provide Islanders with a concrete information base for intergovernmental dialogue and the formulation of policies by each government with a view towards regional trends and precedents in other Pacific Islands states. A few examples include: new states like the Federated States of Micronesia which were drafting the kinds of foreign investment laws that already were in place in Cook Islands. Papua New Guinea's experience in building cooperation between government and landowners to create special environmental areas had potential value as a precedent for policy makers in Fiji, Western Samoa and Vanuatu. A wider understanding of Fiji's wage/price structure and foreign investment climate might lead other Pacific Islands nations to consider adopting similar policies to grow and diversify their economies.

By also making this kind of information more widely available to users located in the metropolitan powers, the database would enhance the ability of the private sector to increase trade activity with the Pacific Islands region by making laws, foreign investment regulations, and the conditions of trade clear and visible to all parties.

Changes in the Design Concept Result in Funding

After an extensive (and unsuccessful) search for funding from national and international foundations, the project was revised to create more specific improvements in how Pacific Island nations communicated with the rest of the world. Project funding now was sought for development of an on-line database service that would stimulate trade among Pacific Islands states, and between them and other major trading partners. Building on concepts developed by the Canterbury Development Council in Christchurch, New Zealand, the Principal Investigator began development of a database and electronic library whose specific purpose was to promote products and services originating in the Pacific Islands to potential customers within the region and abroad. The virtual electronic library portion of the database would serve as a set of documents backing-up the trade-centered activity of the database.

After a careful examination of the World Trade Center Database, and the US Dept. of Commerce National Trade Data Bank, it was determined that there was no database designed to move specific goods and services produced in the Pacific Islands states into US markets or other markets world-wide. In fact, the US Dept. of Commerce's NTDB generally failed to include trade profiles for most Pacific Island states. These profiles most often are supplied by the Foreign Commercial Officer at US Embassies, and profiles existed for only two of the 21 Pacific Islands states. On this basis, a seed grant was provided by the United States Agency for International Development.

Hurdles in the Distribution of PIBN Services

Internet services in the Pacific Islands generally are at a low level. In October 1992, the University of the South Pacific was using a 1200 baud connection to call into the University of Waikato, New Zealand, to obtain twice-daily dumps of its E-mail. By October 1995, USP had its own 4800 baud line for its Internet link. Government agencies in Suva, do not have Internet access, but Fintel, Fiji's overseas telephone corporation, plans to initiate trial services in the first half of 1996. With the reconfiguration of its satellite and switching upgrades to eight stations, PeaceSat soon will provide time-limited direct remote data communications to the eight upgraded stations on its Pacific network. From the PeaceSat node in Honolulu, users can move onto the UH Internet node. In remote areas like Kiribati and Tuvalu, there is the possibility of receiving e-mail through a dial-up link.

There are some notable exceptions to the paucity of Internet services in the Pacific. SOPAC in Suva, Fiji is fully served and technologically current, as is ORSTOM in Tahiti with its four 9600 baud lines into Paris, and Papua New Guinea has established T-1 links into Aarnet.

Combatting North/South Inequalities

Any discussion of the technical considerations of the project would not be complete without a discussion of its cross-cultural considerations. While these considerations may seem only technical, they speak to a large gap between Pacific Islands states and the region's metropolitan powers in their level of the connectivity. While that gap may not be felt critically in Washington or Canberra, it certainly is apparent to Pacific Islanders who could use Internet services to bridge thousands of miles of ocean. It became obvious that the trade database envisioned by the Pacific Islands Development Program would have to patch together the Internet services that Pacific Islanders did receive to create comparable two-way flows between their nations and the metropolitan powers in the exchange of trade-related information.

It was envisioned that the East-West Center server or a server located directly in Pacific Islands Development Program would distribute the database over the Internet. To meet Pacific Islanders' needs, a call-back system was considered first so that Pacific Islanders to call directly into the system, identify themselves, and receive a call back from the PIDP computer. This system avoided the high tolls that most Pacific telecoms charge for international service. It was abandoned because of high development and operating costs, and because standard line service between Hawaii and much of the Pacific is generally poor and undependable.

Project staff also noticed that telecom services in the Pacific were changing quickly and that Internet service should follow. Three years ago, Internet representatives said that they didn't expect to reach the Pacific Islands for another fifteen to twenty years. Yet, three years after the Pacific Islands Business Network was first conceived, PNG and French Polynesia have full Internet service, Fiji's Fintel is about to begin trial services, and PeaceSat is about to establish time-limited services in eight other locations.

The Principal Investigator also began considering a variety of media for distributing the database in the Pacific, such as CD-ROM and diskettes for those locations that lacked Internet service. Using CD-ROM technology, the FSM Department of Commerce and Industry now is considering providing PIBN database services to each of its proposed Business Opportunity Centers in provincial town locations. To accommodate those locales with Internet access, but with limited communication speeds, optional visuals will be programmed into the database, and consideration given to PC emulator software that would allow users in the Pacific to call in with a search strategy already formed and simply use the search engine to download information from the server.

The Canterbury Development Corporation Model

The Canterbury Development Corporation (CDC) based in Christchurch, New Zealand, has developed a database service designed to link business customers with manufacturers and suppliers located within New Zealand's Canterbury province. Their goal is to use information about products made in Canterbury or distributed there to promote their sale within Canterbury or anywhere outside it. It is a primarily business-to-business information service. Prospective purchasers may inquirein person or by phone about products and services . All searching is mediated and done by a professional during office hours. The CDC claims that 40% of all enquiries have lead to purchases or investment in Canterbury Province.

The CDC also maintains a list of potential investors and their specific interests and requirements, along with a similar list of businesses in Canterbury seeking investment. It attempts to bring these parties together, without becoming involved directly in any transactions.

Building on these concepts, the Principal Investigator sought to build a database that could be searched by unsophisticated computer users at any time of day, and that would highlight individual products as well as the corporations that made them. The goal was to provide sufficient business-to-business on-line information about an individual product and its manufacturer to enable a corporate purchasing agent to arrange for purchase off-line.

Because businesses in the Pacific and their executives often are difficult to locate from afar, the database also had to provide a directory of executives, business names, businesses listed by product sectors, as well as brand names, on a regional and country-by-country basis. Because the PIBN focuses on the information needs of business and industrial clients, it also allows users to search for particular types of production or service technology. Sophisticated users may search for companies or individual products by U.S. Dept. of Commerce Standard Industrial Classification codes or by the harmonized international shipping codes. Each product record is designed to include visual information about the product, as well as size, content, technical specifications, and information about how and in what quantities it is made available for purchase.

The Pacific Islands Business Network is programmed in Microsoft Access, a current Microsoft database manager that is likely to receive maintenance and updates for some time to come. The user interfaces are object-oriented and designed to mimic the kinds of interactions that office workers encounter when working with Microsoft Windows. Windows and Microsoft Word are the most familiar software programs in the Pacific Islands, and are readily understood in most offices.

While much of the Pacific Islands Business Network resembles a digitized product directory, it will include a business profile and maps of each country it serves, laws and regulations relevant to purchasing and importing goods from the Island nations, foreign investment laws, passport and visa information, as well as basic statistics, development plans and other Pacific Islands government-published documents relevant to conducting business or investing in the Pacific Islands region. It also allows a business to note its need for investment, and for potential investors to register their specific interests in the region.

Future Developments

One intention of the Pacific Islands Business Network is to serve as the information base of the US-Pacific Islands Nations Joint Commercial Commission whose Secretariat is housed in the Pacific Islands Development Program at the East-West Center. The JCC was formed in 1990 at a meeting of then-President George Bush and the heads of state of fourteen Pacific Island nations. In particular, the PIBN's investor register may be of importance to JCC officials as they attempt to bolster overseas investment in the region.

In its trial phases, the Pacific Islands Business Network has focused its data gathering efforts on Fiji, a relatively developed and diversified Pacific economy. Using Fiji as a test example, the project principals contacted the Fiji Trade and Investment Board to gather data using the survey instruments designed by the project team. A similar effort now is underway with the Department of Commerce and Industry in the Federated States of Micronesia.

Although the PIBN is designed primarily for business-to-business communications, it will be interesting to see if groups ranging from village handicraft cooperatives to small hotels and village-level tourist accommodations will use the PIBN to market their products to individual consumers. While larger manufacturing industries in Fiji, such as garments and sugar, have long marketed their own products, one primary goal of the PIBN is to bring small suppliers of goods and services into the international marketplace. It also is hoped that the PIBN might serve as a means for bringing the products of small, often indigenously-owned businesses to a wider marketplace. Conversely, surveys and interviews with Pacific Islands businesses indicate that they will use the Pacific Islands Business Network as a long-awaited information base to source products made in the United States.

Libraries on the Information Superhighway: the Australian Experience

Carole A. Alcock
Department of
Information and Communication Technology
University of Wollongong
New South Wales
Australia

Abstract

This paper draws on a survey of Australian Academic and major Public libraries and investigates the extent and direction of online information delivery provided through these organisations. The survey indicated an anticipation among librarians of a trend towards wholly electronic information publication, delivery and storage. What will this mean for the future of libraries, the role of librarians and hence also for equity of access to information? This paper provides an insight into the current situation in Australian libraries and into their approaches to electronic information provision in a highly networked environment.

Libraries have eagerly adopted the new technologies at a rate which must call into question the staid and conservative image with which librarians are portrayed by the popular media. Certainly, for many librarians, the idea that their book and journal collections will some day be supplanted by online or other electronic services, is anathema. But for others, this fits neatly into the politics of managing collections, not in spite of, but because of the existing economic imperatives. Serials collections are an interesting case in point. Not only are the hardcopy indexing and abstracting services being displaced by electronic services but, increasingly, librarians will be able to choose whether they subscribe to an expensive journal, or provide access to it via the equivalent full-text database online, possibly charging the requestor for this service. Such choices are already being made. This paper draws on a survey of Australian Academic and major Public libraries and investigates the extent and direction of online information delivery provided for both research and private use through these organisations. The survey indicated an anticipation among librarians of a trend towards wholly electronic information publication, delivery and storage. What will this mean for the future of libraries, the role of librarians and hence also for equity of access to information? This paper provides an insight into the current situation in Australian libraries and into their approaches to electronic information provision in a highly networked environment.

During the past ten years, library technology has been transformed. Where paper based technologies once ruled, computers now provide a major form of access to information resources both within and without the library walls. Once bastions of print, libraries now actively promote electronic information tools, whether simply via online catalogues or CD-ROMs or through the more sophisticated international networks. What changes can we anticipate in the next ten years? Will the library exist at all as we know it? It is certain that the changes will be equally as marked as is apparent in the changes noted in the following pages. Libraries without walls, information super highways, instant information access to home offices, interactivity, high quality graphics with audio and video complementing text, three-dimensional holograms, high speed transmission independent of location and physical connection, portable/pocketable(!) notebook style access tools: already, these are far from the realms of fantasy. They are much closer than the current library technology appeared to be ten years ago.

Until the early eighties, the card catalogue was the most common tool for locating material in library collections in Australia. Prior to that, some use was being made of microfilm, particularly for the National Union Catalogues and also for recording borrowings by photographing book and borrower record cards. Microfilm was also used for preserving a photo record of fragile material, and for making available large collections of bulky printed publications in a compact form, an important attribute where space is at a premium. Microfilm is still used for this latter, most valuable purpose, but it is no longer seen as the ultimate storage medium, neither for its compactness, nor its accessibility. Developments in computing and communications technology, particularly during the 1980s and early 1990s, have raised expectations. The researcher demands information instantly, preferably at the desktop and in facsimile. Long waits for interlibrary loans or time consuming visits to larger centres are seen as unnecessary inconveniences. The technology has expanded the research community's horizons, and libraries have been an important factor in this revolution in information access. Indeed, in most research communities, it was through libraries that much of the new technology now available at the researcher's desk, first appeared. It is not only the research community which is benefiting from these changes. The Public library sector too, is actively promoting and facilitating access to networked information resources. While at present, this access is largely restricted to major State and City libraries, smaller community libraries are also beginning to take advantage of the new services. As the survey below made clear, libraries in Australia are very much an active part of the world wide information "superhighway".

Survey of Australian Academic and major Public libraries

Who was covered?

Public access to online information in Australia is provided by the large State and Academic libraries, by the National Library and by some of the larger Public libraries in major cities. These were the libraries targeted in this survey. The table below gives an indication of the number of libraries approached in each category and the number of responses received.

Table 1
Libraries included by category

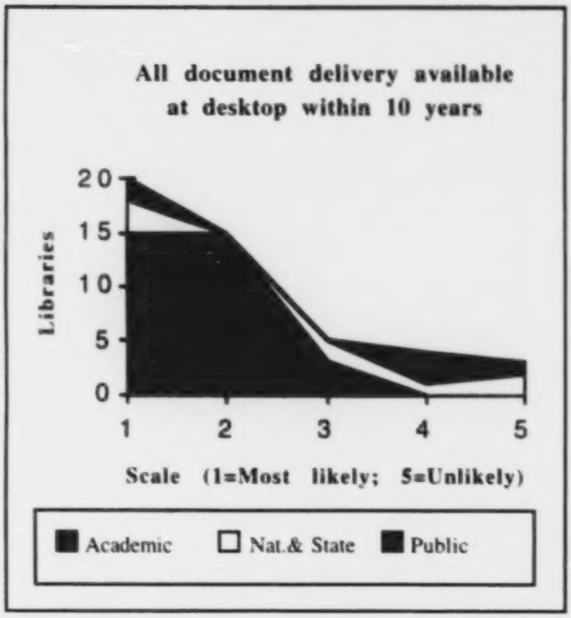
Category	*Num.*	*Responses*	
Academic	37	33	
National	1	1	
State	7	7	(All States)
Public	9	7	
Total	54	48	

Not all campuses of academic institutions were surveyed but the sample does cover the majority of major Universities. The National and all the State Libraries responded as did all but one of the capital city libraries who were approached. Hobart and Adelaide Public Libraries are under the umbrella of the State Library in their respective States. Consequently, they were not included as they were covered in the State Libraries' responses. Responses from the large Public libraries indicate much less activity in the delivery of online information services than in the State and Academic libraries. For example, two of the seven responding Public libraries had no access to international databases and only three indicated access to AARNet (Australian Academic and Research Network), Australia's main link to the Internet.[1] It is evident from these responses that little would have been gained by extending this study to smaller Public libraries at that stage, although this is changing, particularly in Victoria, as will be seen later in this paper.[2]

The view from the library

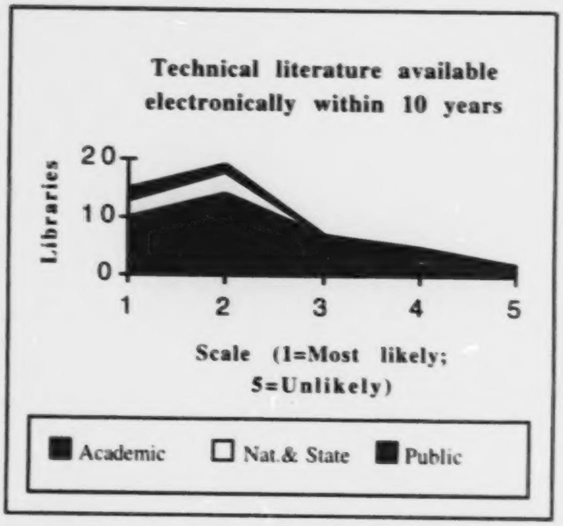
Document delivery available at desktop?

The appearance of full-text documents such as government reports on world wide web pages has raised the hopes of many librarians that soon all citizens, no matter where they live, will have easy access to a range of sources once only available in major centres. Indeed, it has been the expressed desire of some researchers that all their text-based information needs be met without their having to leave their offices. In this age of computer networks where many individuals do have appropriate access to the tools, this may well be achievable. One respondent to the survey indicated that this was already happening at their institution. However, charges are usually attached to requests for electronic document delivery whether these be standard, photocopied articles faxed to the requestor or full-text (ASCII format) papers provided through services like DIALOG (Knight-Ridder). As well, copyright restrictions on reproduction of documents obtained through Inter-Library Loans services require a signed agreement regarding the use of the material. Until electronic signatures are secure and in general use and charging arrangements are equally resolved, a fully electronic document delivery service cannot be achieved. Nevertheless, it can be presumed that this development will be strongly supported by at least one sector of the library profession if the responses below are an indication. Thirty-five of the forty-seven respondents stated that it was more than likely that all document delivery would be available in this manner within the next ten years. Only seven said that this was unlikely.



Technical literature available electronically

A problem for libraries has been the provision of up to date scientific and technical literature. Lengthy procedures involved in the publication of books and refereed journal articles can mean that this type of resource can be several years out of date by the time it reaches the library shelves. As well, the process of hard copy provision can be very costly. Reasonable profit margins for publishers may inflate the price of technical literature for which there is only a small, specialist demand. If technical literature can be provided in both a more timely and cost efficient manner through electronic delivery, it is in the interests of library clientele that this be achieved. Publishers, too, may be relieved of the obligation to publish material where profitability is uncertain. Indeed, the involvement of technical publishers in the electronic information industry (eg. Reed Elseviers) would indicate a belief on their part that this is the direction they will be forced to take in the near future if they are to survive. Librarians involved in the delivery of electronic information are well aware of the changes occurring in this area. Responses indicated a widely held view that online delivery of this type of literature was imminent.


Technical literature available electronically within 10 years

Adoption of new technologies in Australian Libraries

Access to AARNet/Telstra Internet Services

Forty-four of the forty-eight libraries surveyed had access to AARNet. The four which did not were public libraries. Doubtless this will change and network access will be extended to even the most remote public libraries. Indeed, since this survey was conducted, publicity has been given to at least two local council areas which are promoting access to the Internet via AARNet. The Victorian State Library's Vicnet is providing access for that states public libraries. Doubtless other states will follow suit. This will greatly increase the services (including database resources) available to public libraries and to their clientele.

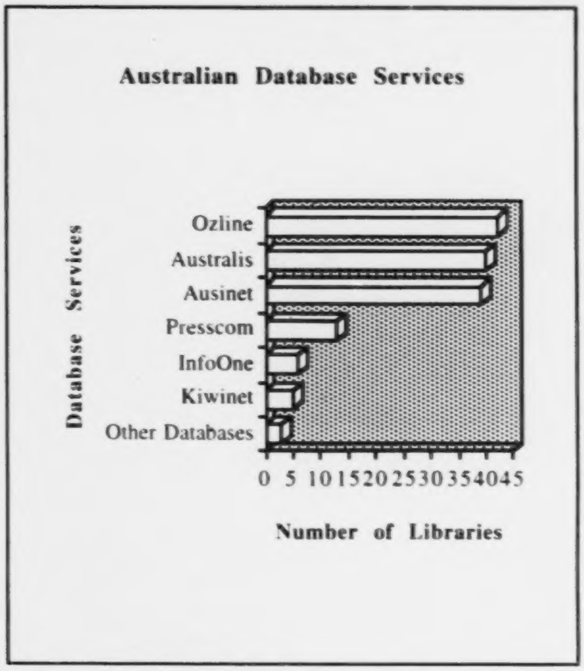
	Num.Libs.	*AARNet* Access
Academic	33	33
National	1	1
Public	7	3
State	7	7
All	48	44

Although libraries themselves had access to AARNet, not all provided access to library patrons. Only twenty-seven, in all, allowed patrons to use this facility. Even where academic libraries were concerned, ten of the thirty-three were unable to extend access to the network to include their patrons. Some academic campuses provide universal Internet/AARNet access to students and staff. Others provide limited access to some members of the campus. This survey found that there were at least ten campuses where no access was available to students, even through their libraries. This is disappointing as the network provides a real opportunity to improve access to powerful research tools that in the past most students were denied. The variety of network tools available and the extent of database access provided through the network are detailed in the following sections.

Services available within and through libraries

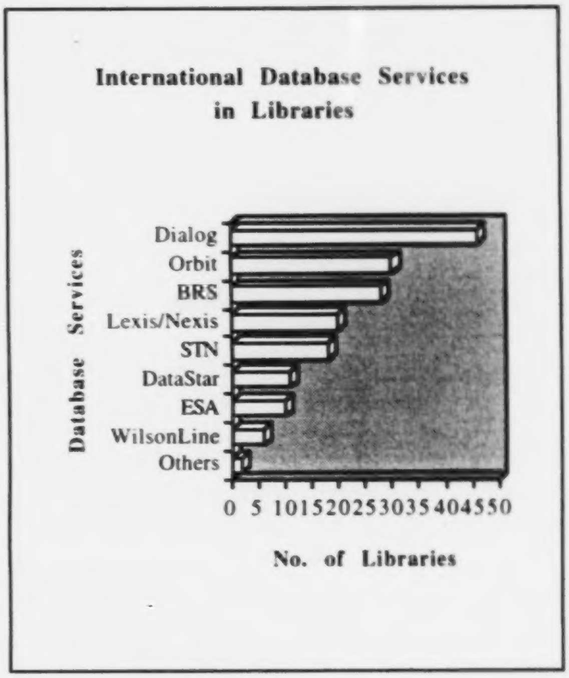
Traditional online database services

At the time this survey was conducted, some changes were occurring in the Australian online database industry as regards ownership and control and changes continue to occur. In the graph below, Ozline and Australis are listed separately. Australis databases have been taken up by the National Library of Australia (NLA) and are now offered through the NLA's Ozline service. Ausinet[3] has been sold by its owners, Ferntree, and is now owned by an Australian newspaper company, John Fairfax Holdings Limited, mirroring the trends seen internationally of newspaper and other publishing organisations purchasing large online database companies (for example: Knight-Ridder and Dialog; Reed Elsevier and MeadData Central).



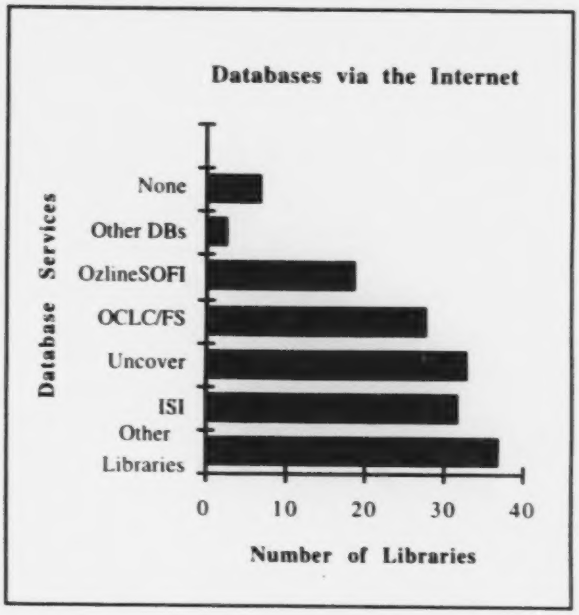
Of the nineteen services used, three had a high percentage of support. The graph above shows that Ausinet and Australis/Ozline are the dominant, online information providers with forty-two of the forty-eight libraries using Ozline, forty using Australis and thirty-nine using Ausinet. Hence, it can be seen that most libraries use all three. What was surprising was that not all academic libraries had access to any one of these services. Indeed, one library did not use them at all, although that library was in the process of reviewing its electronic information provision. Ozline (and Australis) databases are now available via AARNet and many Academic libraries provide access to them in this way (Statistics on this provision are given latter). It is only a matter of time before Ausinet is similarly accessible. Ausinet staff have advised that this is planned and will proceed once security measures have been resolved. The NLA's proposed National Document and Information Service (NDIS) which will combine existing online database services (Australia's ABN and New Zealand's NZBN)[4] making them more easily accessible via the network will also, more than likely, expand demand.[5] Sherry Quinn, in her 1993 summary of Australian database resources anticipated that within two or three years, the old systems might have disappeared.[6] Clearly, the systems are changing, but many of these database resources still have an assured future where libraries are concerned.

Among the other Australian and New Zealand database providers, Presscom was used by thirteen libraries, InfoOne by six and KiwiNet (from New Zealand) by five. The remaining providers were used by three or fewer than three of the libraries in this study. Most were more narrowly based or specialist, than the three major vendors. This pattern of favouring the more broadly based vendors is also evident for international service providers as survey results presented in the following graph show.



New, networked databases

Unlike the familiar network search tools mentioned elsewhere in this paper, traditional databases provided through the network, present a more structured environment for obtaining information. While tools like gopher, www browsers and WAIS aim to help users make sense of the many options for obtaining access to network resources, they are still more dependent on luck than skill. Most of the database services on the other hand have some kind of controlled subject search option, often having as their base a well established database resource that existed prior to the expanded network access we have today. They have not been put together in the same ad hoc manner that has attended the provision of much of the material available through other resources on the Internet. Libraries worldwide have been active in both their production and their provision. Hence they are a valued addition to many libraries repertoire of services to their clients. This is demonstrated clearly below, Uncover, ISI Current Contents and OCLC First Search being well supported by twenty-eight or more libraries and the National Library's Ozline/SOFI, by nineteen. Other library catalogues were also used through the network, by thirty seven of the forty-eight respondents. Many of these services provide valuable information to assist in locating and gaining access to material both within Australia and beyond. They also provide access to database information formerly only available through charged for online information services like those provided through Dialog (Knight-Ridder). Whether they continue to be provided free of charge remains to be seen.



World Wide Web access

Libraries were asked what services they made available through the network. Focus was placed on basic tools such as gopher, the various world wide web browsers and whether they maintained some form of local electronic archive. Only six answered positively to the last (maintaining an electronic archive or ftp site) although one respondent said that they used gopher for this purpose. Gopher is a popular and relatively easy to use tool with more than sixty per cent of academic libraries and almost forty percent of other libraries making use of this service. Seventy percent of academic and forty percent of other libraries used some form of access tool (gopher or mosaic, etc.). There are many World Wide Web browsers, Mosaic being the most popular at the time of this survey. (Netscape is now more widely available.) Respondents were asked to indicate whether they used one of the Web browsers and, in particular, if they had access to Mosaic. Seventeen libraries either had access or planned access to Mosaic. It was surprising that less than fifty percent of the libraries surveyed had access to some form of web browser. Another network research tool is WAIS. This software had received some publicity at library conferences so it was again surprising that only seven libraries indicated that they used this system. Perhaps the time involved in setting these systems up and their unpredictability may have been one reason that they were not generally made available. Their impreciseness in the way they access information may have been another. There is no guarantee with any of these services that the result will provide high quality information.

As has been noted, not only are more libraries gaining access to the worldwide web, many are now establishing web homepages which provide access to library information resources and links to useful services. Of the libraries surveyed, twenty-seven now have web addresses. Some State Libraries are encouraging participation by the smaller city and town council libraries. Through Victoria's Vicnet,[7] twenty-three public libraries now have Internet access with eleven providing public access terminals. Home pages are also being set up for these community based libraries. In New South Wales, ILANET at the State Library provides access for a fee to a variety of information services "to over 1,000 libraries and information agencies throughout Australasia."[8] Some city councils, like Ipswich in Queensland, are providing Internet access independently.[9] Ipswich plans to provide an electronic library. Setting an example for the library community, the Australian Library and Information Association (ALIA) which originally provided its web page through the National Library, now has its own address.[10] Links to libraries throughout Australia and world wide are to be found through the web pages of educational organisations, general net directories and other libraries. Clearly, the adoption of this new access tool has demonstrated a high degree energy and enthusiasm on the part of the Australian library community.

Supplanting book and journal collections with online services?

The success of CD-ROMs: an intermediate technology?

Of the forty-eight libraries surveyed, all had invested in CD-ROM technology. The larger State libraries were the most heavily committed in this area with one providing access to 101 CD-ROM titles. Academic libraries, too, are investing considerable funds in this area, almost matching the State libraries. CD-ROMs are expensive, many costing several thousands of dollars for a subscription. Networking to several machines or sites incurs an extra fee and, in some instances, the library may only have a licence to use the discs: they may not own them. Even libraries with small collections are committing a sizeable proportion of their budgets to maintain their collection. It is significant that libraries are prepared to allocate funding for this technology to an extent which was never possible with traditional online databases. A modest collection of around twenty titles may cost a library about $60,000 annually, excluding costs of equipment. In a report on the Australian online industry published in 1992, Elizabeth Oley suggested that the easy access to information which CD-ROMs provide for all library patrons may have resulted in a decline in online searching.[11] It will be interesting to see whether access to networked database resources has a similar impact on library commitment to CD-ROM technology.

Full-text databases online

Full-text availability in Australia: International and Australian

Major international database vendors like Lexis/Nexis have provided full-text resources in Australia for over a decade. Locally, Ausinet, InfoOne and PressCom are among the vendors making Australian full-text resources available to libraries. Where newspapers are concerned, there are twenty Australian papers available electronically and five New Zealand titles.[12] Full-text resources appearing on the world wide web like government reports and legislation are among the more interesting recent developments. As well, some Australian electronic journals are being produced. A list of these along with that of electronic newsletters and discussion groups is available through the National Library's homepage.[13] These services are still being developed. It is uncertain whether a charge will attach in the future although where overlap occurs with private sector interests it seems likely that some charging will be inevitable.

Charging for the service

Situation in Australian libraries

Where Australian libraries are concerned, there appears to be no real agreement on the approach to charging for traditional online information. Most do charge sometimes, for some of the costs involved. Of the forty-eight libraries responding twenty-two gave an unequivocal "Yes" to the question on charging, while a further eighteen charge some of the time. Only eight libraries stated that they did not levy a charge for searching. It was clear from the response to the survey that little consistency exists in approaches to charging for online information. Most libraries are attempting to do the best that they can utilising existing resources and surviving within their sometimes meagre budgets.

At the time of the survey charges for network use were not generally made. Only one library said that it charged for network use and that was limited to database searching using Ozline. Where the future was concerned, however, fourteen said they were unsure, one stated that they would charge and one that they would charge for OCLC searches on the network. The remaining twenty-three indicated that there were no plans to charge in the near future. This may of course, no longer be the case, given the changes which are occurring with Telstra's purchase of AARNet and the certainty that charges to all institutions will increase. Whether libraries are able to budget to maintain some level of free access will no doubt depend on the level to which charges rise.

The future of charging: predictions

"Internet cafes" appear to have gained popularity worldwide. The idea is to provide a drop in place for anyone wanting to use Internet facilities without the expense of purchasing equipment. Such services are now appearing in cities in Australia.[14] In Sydney there is Remo's in George Street and Melbourne has the Netcafe at St Kilda. Even the National Library has joined the trend, providing Netscape access on two PCs in the Brindabella Bistro, with positive responses from patrons. It is assumed that an increasing number of libraries will provide some form of access to networked information services to their patrons, either within their walls or remotely. As indicated in earlier sections of this paper, many database services are already being provided through the library. Network access to databases once only available through expensive, mediated online searches seemed to be a breakthrough in providing equitable access to all library patrons. However, there are now moves to charge end users for their use of the Internet. Only ten of the forty-five librarians who responded to the survey question on charging thought it was unlikely that such a service would incur a charge. Eighteen thought it likely within five years and twenty-four, within ten. Since this questionnaire was undertaken, it seems certain that charges for network use will be passed on to the end user, whether within libraries or independently.

Extent and direction of online information delivery for both research and private use

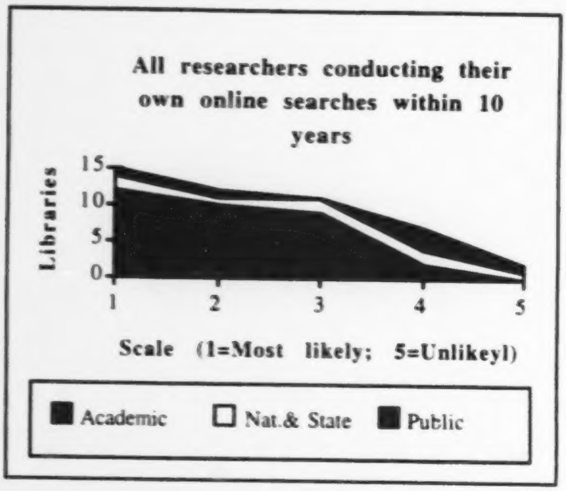
Traditional online services

Of the thirty-five libraries stating that a budget was allocated for traditional online services, twenty-nine were able to provide approximate figures on the amount available. This varied considerably depending on the size and type of library concerned. Hence little can be seen from presenting averages or means as no absolute statistics were available on numbers of patrons using the services. Perhaps a better indicator of use of these services can be seen in the search statistics. Where the number of searches conducted by intermediaries in libraries is concerned, the survey indicated only a slight overall trend downwards in the use of traditional online services among academic libraries and little or no change in the direction for State and Public libraries. It is doubtful that the growth of the Internet services has as yet had an impact on traditional online services although they may well supplant them in the near future.

Researchers doing their own searching

Many researchers are now able to do their own online searches through databases provided over the network.

Only some of the traditional online databases are available in this way at present. Many of the more comprehensive and expensive databases are either not available through the network or are only available to those with appropriate accounts and who are able to be billed for the service. Intermediaries are still necessary for such services. Librarians were asked if they saw a trend towards more searching being done by the "end user", the person requiring the information. While the initial response was that this was unlikely within the next five years, within ten it was more probable according to twenty-seven of the forty-seven respondents. Only nine thought it was still unlikely within ten years.



Trend towards wholly electronic information publication, delivery and storage?

Newspapers and web pages

In Australia as elsewhere, newspapers are beginning to appear on the world wide web. Browsers like Netscape allow easy, if slow, access to such resources and are becoming popular. *The Sydney Morning Herald*, Melbourne's *Age* and *The Australian Financial Review* all provide access to their computer pages via the web. Access to overseas papers is also an area of interest. The British *Daily Telegraph* and the *New York Times* are two examples. Speed of access when using these services is a major drawback at present, but the potential of these developments is exciting.

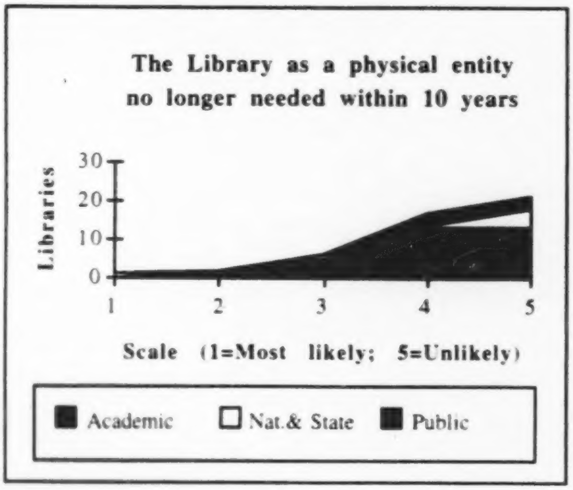
Government publications on the world wide web

The Australian Federal Government and some of the State governments have begun making available their publications, including legislation, through web pages.[15] The National Library of Australia is an important link to these resources providing access nodes through its web page.[16] As more public libraries come online through State networks like Vicnet, public access to government information will be greatly expanded. This is in contrast to recent moves by governments to limit distribution of many print publications to all but a few deposit libraries. It will be interesting to see whether charges will attach to these services once they become more well established.

The future of libraries and the role of librarians in Australia

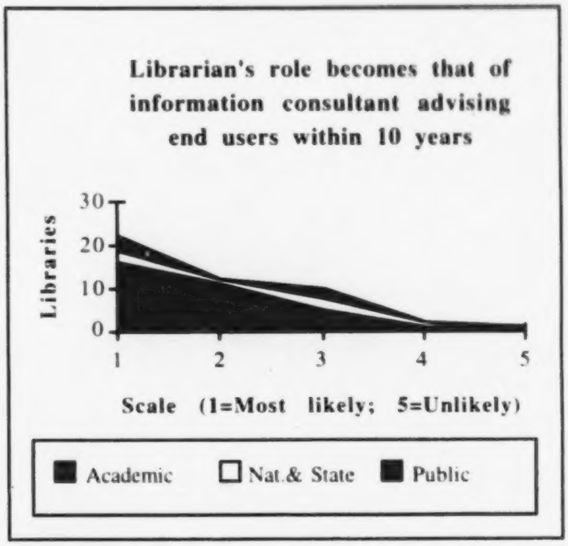
Libraries: virtual or physical?

There has been much discussion both in print and elsewhere regarding the need for the continuing existence of the library as a physical entity. Most librarians are familiar with the main arguments for and against such a proposition: equity of access for the less affluent on the one hand; ease of access for the technologically privileged on the other. As might be anticipated, when asked for an opinion on this proposition, librarians expressed the view that it was extremely unlikely that libraries would no longer be needed within five years (forty-four respondents) with only a slight movement in opinion on this proposition 'within ten years' (thirty-six respondents still stating that such a change was unlikely). Libraries have existed as physical sites (if with varying purposes) for more than two thousand years. It seems reasonable to assume that they will continue to do so.



Librarians role?

While the perspective expressed as regards the survival of libraries may have seemed conservative, where the role of librarians is concerned this was certainly not the case. The library profession was one of the earliest to be confronted with the introduction of computer technology. Computerised databases of bibliographic resources were first developed in the late 1960s and libraries have progressively automated most of their operations since then. Consequently, librarians, by the nature of their profession, have had to be open to change. New computer systems, new software packages, online information delivery, CD-ROM technology, multi-media, computer networks: the changes continue and often it has been in libraries where these technologies have first appeared or been adopted. Australian librarians view themselves as information professionals which is quite a different image from that portrayed by outsiders, particularly the mass media. Many would say their role is already that of information consultant to end users and their responses when questioned on their future role confirm that if they do not see themselves in this way now, that this is the direction in which they will be heading within the next five to ten years. It is a highly motivated and confident view of their role, one which projects a positive image of a profession in transition.


Librarian's role becomes that of information consultant advising end users within 10 years

Conclusion

The expanding access to the new network technologies is changing the face of Australian libraries. From the early COM catalogues, through the online public access systems, to CD-ROMs and now, the explosion of networked resources, Australian libraries have remained open to the changing technology to the extent that librarians might sometimes be accused of being technology driven. Indeed, the new networked databases and electronic archives provide a constant challenge, with each service presenting some variation in the protocol required to gain access to its resources. Libraries in Australia provide access to a good range of online services, both local and international. As well, they have entered into the new area of networked provision of databases with services like Uncover, OCLC First Search, ISI Current Contents and the Australian Ozline/SOFI databases being widely available to library patrons. In many instances, these are available remote to the library and end user searching being encouraged.

During the three year period preceding this survey, there appears to have been a slight drop in mediated online searching. This is more evident in academic libraries than in the State libraries. However, the trend is by no means consistent, nor has the change been very marked. The significant point is that while library patronage has undoubtedly grown, there has been no real increase in library use of these services. With so many new services available, attention will inevitably be focused on providing for information needs in the cheapest (for the client) and most effective or efficient way possible. For example, why would anyone who could easily efficiently and cheaply retrieve high quality information, whether graphic, text, audio or visual in form, and from any location, even consider that a physical site was necessary? If site independent access to all information resources does become a reality, as it is almost certain that it will, will libraries survive? It is anticipated that electronic information provision will become the norm and that end users will do more of their own information searching. In spite of suggestions to the contrary, librarians still see a place for libraries and for their profession.

Networking of databases held the promise of easy access to online databases without the expensive charges and telecommunications costs of the traditional system. It seems likely, however, that charging for these services will be instituted. If this occurs, an opportunity to provide greater equity of access will be lost. Nevertheless, it can also be argued that if online vendors can provide information directly to the end user, an intermediary is an added expense. As more, high quality material once lodged in libraries is provided in this way, albeit for a fee and the "user pays" philosophy gains general acceptance, it may be argued that there is no need for a library in the physical sense. Online information vendors will provide an adequate facility.

What are the implications of such a change and how will this affect access to resources for those lacking either the physical or the financial capacity to take advantage of this technology? For almost certainly, individual charging and the consequent inequity of access, will be a feature of these changes. It is essential that the services provided be examined closely and that policy decisions be taken that ensure appropriate dissemination of information resources, independent of ability to pay. This is particularly important in areas such as education and research upon which a country's economic well-being rests.

The prospect of an ever expanding information resource available via the telecommunications network and independent of place, is exciting. As elsewhere in the world, there is an explosion in the development of world wide web sites in libraries, each providing some new link in the information chain. The constant stream of articles appearing in the news media reflects the general level of enthusiasm for what is commonly referred to as the "information superhighway", as does the emphasis on the importance of putting in place a national, information infrastructure. Whether the technology continues to reside in a specific location such as a library is irrelevant. Facilitating access is the issue of greatest importance.

BIBLIOGRAPHY

ANON. *Internet cafes.* In: **Incite.** v.16(July 1995):18.

ANON. *Reed Elsevier to be new owner of LEXIS-NEXIS.* In: **Online Currents.** v.9(8):1.

AUSTRALIAN FEDERAL LEGISLATION homepage: http://austlii.law.uts.edu.au/

BUNDY, Alan and Judith (eds). **Australian Libraries: the essential directory.** 3rd ed. Blackwood, SA: Auslib Press, 1995:103

HENDERSON, Sarah . *Online information networks.* In: Peter Biskup and Margaret Henty (eds). **Library for the Nation.** Belconnen, ACT: AARL and the NLA,1991:60-67

HUSTON, Geoff. *The future of online services.* In: **Online Services**: a conference held at Sheraton Wentworth, Sydney, 26-27 July, 1995

IPSWICH CITY COUNCIL's homepage: http://iccu6.ipswichcity.qld.gov.au/

NATIONAL LIBRARYs home page: http://www.nla.gov.au/

NDIS and document delivery. In: **Incite.** August 1995: v.16(8):21

OLEY, Elizabeth. *The current situation and future prospects of the online industry in Australia.* In: **Online Review.** 1992: v.16(6): 369-378.

OXLEY, Sandra. *Electronic access to Australian and New Zealand business information.* In: **Management.** June 1995: 16-18.

QUINN, Sherry. *Australian databases and information services:Summary of developments: 1988-1992.* In: **Information Online and Ondisc '93.** Sydney: Information Science Section, ALIA, 1993:49-69

VICNET's homepage: http://www.vicnet.net.au/

GLOSSARY

AAP Australian Associated Press
AARNet: Aust. Academic & Research Libraries Network
ABN Australian Bibliographic Network
ASCOT Aust. Securities Commission online service
Australis CSIRO databases
Ausinet: Australian database vendor
gopher: network access tool
Info-One: Australian database service; legal information
KiwiNet: New Zealand database service
Mosaic: world wide web browser; text and pictures
Netscape: world wide web browser; text and pictures
Ozline/SOFI: database service from the National Library
PressCom: Australian, full-text, newspaper database
QNIS Queensland Newspapers Information Service
Reuters: international newswire service
Telstra: Australian Telecom
WAIS: Wide Area Information Service
www: World Wide Web

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[1] Telstra, Australia's Telecom, has recently(1995) purchased AARNet (Telstra Internet Services).

[2] One area that has not been covered here is that of TAFE (Technical and Further Education) libraries.

[3] The Ausinet database service was developed in 1977 through the National Library with the cooperation of other libraries in Australia. It moved to the private sector in 1980. [Sarah Henderson. *Online information networks.* In: Peter Biskup and Margaret Henty (eds). **Library for the Nation.** Belconnen, ACT: AARL and the NLA, 1991.]

[4] Jointly funded by the National Libraries of New Zealand and Australia. [Alan and Judith Bundy. **Australian Libraries: the essential directory.** 3rd ed. Blackwood, SA: Auslib Press, 1995:103]

[5] *NDIS and document delivery.* In: **Incite.** August 1995: v.16(8):21: A paper on the impact of NDIS is available at: http://www.nla.gov.au/2/NDIS/illsummp.html

[6] Sherry Quinn. *Australian databases and information services:Summary of developments: 1988-1992.* In: **Information Online and Ondisc '93.** Sydney: Information Science Section, ALIA, 1993:66.

[7] "Vicnet is a joint enterprise of the Victorian State Library and RMIT to bring electronic networking to the people of Victoria." Vicnet's homepage address is: http://www.vicnet.net.au/

[8] See ILANET's web page at http://www.ilanet.slnsw.gov.au/

[9] Ipswich City Councils homepage address is: http://iccu6.ipswichcity.qld.gov.au/

[10] ALIA's home page address is: http://www.alia.org.au/

[11] Elizabeth Oley. *The current situation and future prospects of the online industry in Australia.* In: **Online Review.** 1992: v.16(6): 374.

[12] Sandra Oxley. *Electronic access to Australian and New Zealand business information.* In: **Management.** June 1995: 17.

[13] NLA's home page: http://www.nla.gov.au/

[14] Anon. *Internet cafes.* In: **Incite.** v.16(July 1995):18.

[15] Australian Federal Legislation direct web address is: http://austlii.law.uts.edu.au/

[16] National Library's homepage address is: http://www.nla.gov.au/

MULTIMEDIA AND ASYNCHRONOUS LEARNING: THE DELIVERY OF EDUCATION AND TRAINING UTILIZING THE DIGITAL LIBRARY

Arthur S. Gloster II, Vice Provost
Office for Information Technology
Virginia Commonwealth University
Richmond, Virginia, USA

1. ABSTRACT

Virginia Commonwealth University, comprised of the Academic Campus and the Medical College of Virginia Campus, partnered with IBM, Bell Atlantic and Sprint to utilize technology to deliver asynchronous learning and medical applications. VCU is committed to expand content and deliver off-campus as well as provide access to move support materials through the Digital Library.

A quarter of a century after its establishment as a major, public, urban, research institution, Virginia Commonwealth University is positioned to fully utilize information technology as a revolutionary tool for enhancing the scholarly environment for its faculty, students, and staff. VCU's Strategic Plan recommended embracing information technology as a key component in meeting the challenges of the next century. Creating this new environment will be expensive and new funding is unlikely, so the University will redirect existing resources and form strategic partnerships with both the private sector and other universities committed to change.

The impetus for change stems from three factors. First, higher education is being subjected to the same demands for greater efficiency and productivity that have caused major restructuring in other sectors of society. Second, increased scrutiny from both funding agencies and its population is much different than a decade ago. Third, higher education is assumed to be a key player in applying the benefits of the 'information age' to society.

In a traditional 'synchronous learning' environment, faculty teach at a given time and place dictated by the institution, not necessarily convenient to either the students or instructors. In contrast, in the emerging technological 'asynchronous learning' environment, it is the student who controls the time, place and manner of learning. The Internet, kiosks and voice response systems, and other information technologies will support, enhance, and customize teaching and learning. As VCU establishes its new technology infrastructure, an increasing number of educational components will be delivered asynchronously. Students will be able to view 'on-demand' a digitized version of a film that is archived on a superserver and transmitted to their PC or TV using the VCU network. As this new learning mode of multimedia education-on-demand evolves, students will have greater flexibility in arranging their schedules and choosing an information source that best meets their learning style (Figure 1).

A Digital Library is a database technology solution for the management of the entire spectrum of digitized multimedia information. The Digital Library supports the educational and medical mission of Virginia Commonwealth University and includes, but is not limited to, movies, images, photographs, recordings, text, and radiology images. It allows for the creation and capture, storage and management, search and access, rights and permissions management, and distribution of information. An infrastructure for performance, safety, and intellectual property protection is provided (Figure 2).

VCU DIGITAL LIBRARY
Applications

Media Publishing - archive - production - photo library	Distance Learning - video courses - assignments - photos	Video/Audio Content Hosting - library music - TV and insertion - program delivery	Cultural - rare artifacts - high quality - archival
Content Creation Backend - animation creation - live action files - magazines	Library Digitization - traditional libraries - new colections - existing catalogs	Publishing Distribution - journal images - subscriptions - online/offline	Health - radiology images - high/med quality - existing systems

FIGURE 1: DIGITAL LIBRARY APPLICATIONS

VCU Digital Library
Functional Summary

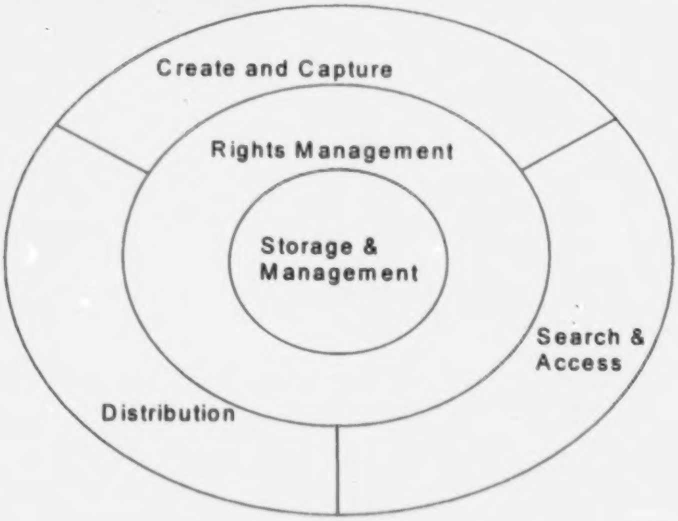

Create and Capture
Rights Management
Storage &
Management
Search &
Access
Distribution

FIGURE 2: DIGITAL LIBRARY FUNCTIONAL SUMMARY

Developing instructional materials for the Digital Library is surprisingly easy and can be done relatively quickly. The skill level of faculty who are using the distributed learning networking approach for instruction ranges from novice to sophisticated. Many faculty create their own complex distributed learning pages using HTML the HyperText Markup Language that underlies distributed learning hypertext programming and linking. At some institutions, programmers develop the basic design of a system, and faculty need only basic e-mail and distributed learning navigation skills to enter assignments and communicate with students. The Digital Library and networking navigation software (such as Netscape navigator, Mosaic, or *Lotus Notes*) nicely integrate access to all types on Internet resources in one easy-to-use interface. Both faculty and students can quickly and easily learn to use this software to navigate the Web, access course materials, post homework assignments, and communicate with colleagues. Many of the distributed learning models implemented in the Digital Library and networking combined approach emphasize a student-centered environment and encourage greater collaboration among students. Emphasis is placed on interactive problem-solving; the teacher is not just an expert, but increasingly takes the role of facilitator.

The Digital Library uses a networked client/server model, with index servers to manage search support data and object servers to manage the digitized objects themselves (Figure 3). The client, index server, and object server form a communications triangle, to permit distribution of the index and object data while retaining a direct path for the object data to reach the client. This relatively simple architectural property is very important in this environment since the object data tends to be relatively large for many digitized objects (such as scanned images, music, or video). The size of these data objects motivates locating frequently used objects close to their user to reduce communications costs and improve performance by minimizing the number of times the object data is copied or relayed. The profusion of readily available source materials on the distributed learning network is ideal for education and research. The true beauty of the distributed learning network lies in the ease with which you can create a hyperlink to existing information, allowing you to take advantage of the expertise and creativity of others without having to "reinvent the wheel." In addition, "human resources" are often readily accessible on the Internet allowing you to enhance your virtual classroom with the introduction of guest speakers and content experts into your chat areas of discussion groups.

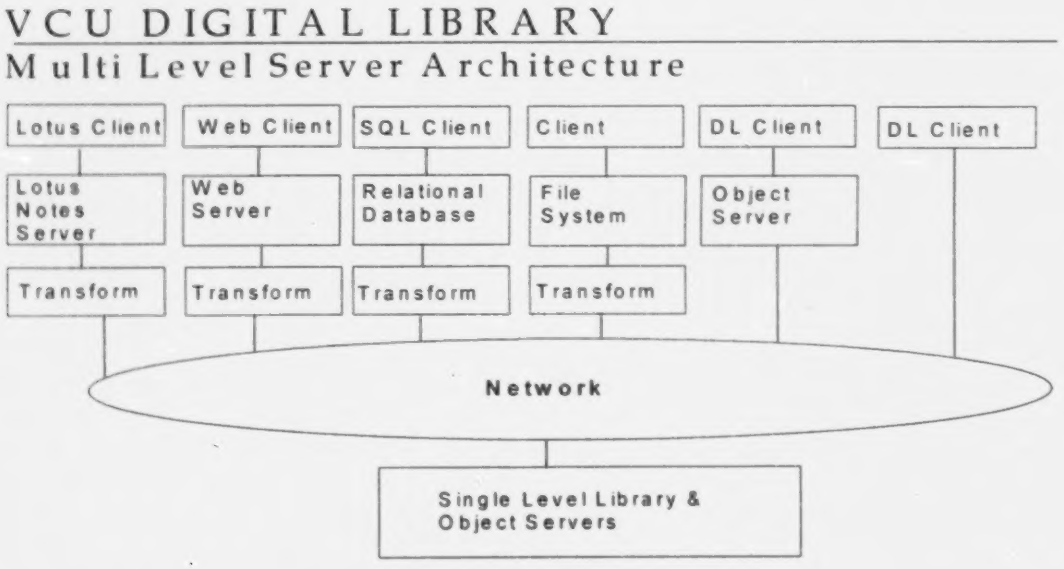


FIGURE 3: DIGITAL LIBRARY SERVER ARCHITECTURE

The IBM version of the Digital Library, which VCU will test for the delivery of multimedia asynchronous learning and medical applications, provides for distribution of content through the Internet and other public and private networks. Secure client technology should be employed to allow for protection of this information. Integration of new key Internet security developments must be a priority to enhance security. The course's instructional content can be closely controlled, and involvement monitored, using the flexible tools available in the Digital Library and networking combined approach.

The Digital Library is an end-to-end solution that encompasses hardware, software, and networking. The following are attributes that are essential in order to construct a robust and scaleable Digital Library:

Content Creation

A wide variety of input devices are supported so that content can be imported into the Digital Library. Currently, VCU uses MacIntosh, SGI, HP and other hardware and software tools to create content. The Digital Library must have the ability to store arbitrary files. It should impose no restrictions on the format of data. In the IBM Digital Library, data is stored in an object server and serves as a repository for sound, data, video, etc.. The only limitations should be those imposed by the file system used on the hardware and operating system platform.

Storage and Management

The Digital Library architecture, index information is stored in a relational database in a library server and object content is stored in an object server. Object servers provide a robust, policy directed storage management system. Policy is set by system administration and specifies how the objects are to be managed. Objects are placed in management classes. Policies control the movement of objects from one storage class to another. This system greatly simplifies the management of large volumes of object data as the data is separated from the index information which is stored on the library server. The Digital Library is designed to maintain extremely large quantities of data. The number of items is limited only by the relational database management system (RDBMS) running under the index server.

Search and Query Techniques

The Digital Library architecture separates index information from content information. The index is maintained in the RDBMS and supports an elaborate and extensive set of query mechanisms. Objects are assigned to index classes defined by users. The Digital Library has a powerful and efficient system that supports both static and dynamically bound queries. Static queries are queries which are preprocessed to execute quickly. Dynamic queries are "on the fly" queries which can be converted to static queries on demand on when a specified threshold is reached.

Information Distribution and Presentation

The Digital Library architecture separates the client from the index and object servers. These three components communicate via TCP/IP or IBM SNA. There are client application programs provided for OS/2 and Windows environments. A programming toolkit supports the creation of customized clients. An interface between World Wide Web (WWW) servers and the IBM Digital Library is under development with Lotus utilizing *Notes*.

Rights Management

The digitization of information allows for the exact duplication of information. This provides a greater exposure to theft for content owners. Therefore, rights management is a crucial feature of the Digital Library. It includes advanced authentication, royalties management, encryption, metering, billing services and watermarking technologies to provide users with secure access to information stored in a digital library, as well as authorized distribution. Rights and permissions management support is characterized by four aspects, the ability to: *Control, Monitor, Authenticate, and Watermark*

Control

Only authorized users should have access to Intellectual Property Objects (IPO's). Rights management provides access control for individual IPO's and goes beyond the security provided by facilities such as RACF (an IBM software package which provides security on a variety of IBM platforms). Permissions management determines the validity of a request for an IPO through rules processing of the IPO's license criteria and user profiles. If permission is granted, then usage rules, usage charges, and the IPO are encrypted and transmitted to the requesting client.

License agreements, both explicit and inherited, define the permitted uses of an object by any given user profile. For example, a user might be permitted to view an object but not print it, play it but not copy it. Use is restricted by client software and/or hardware.

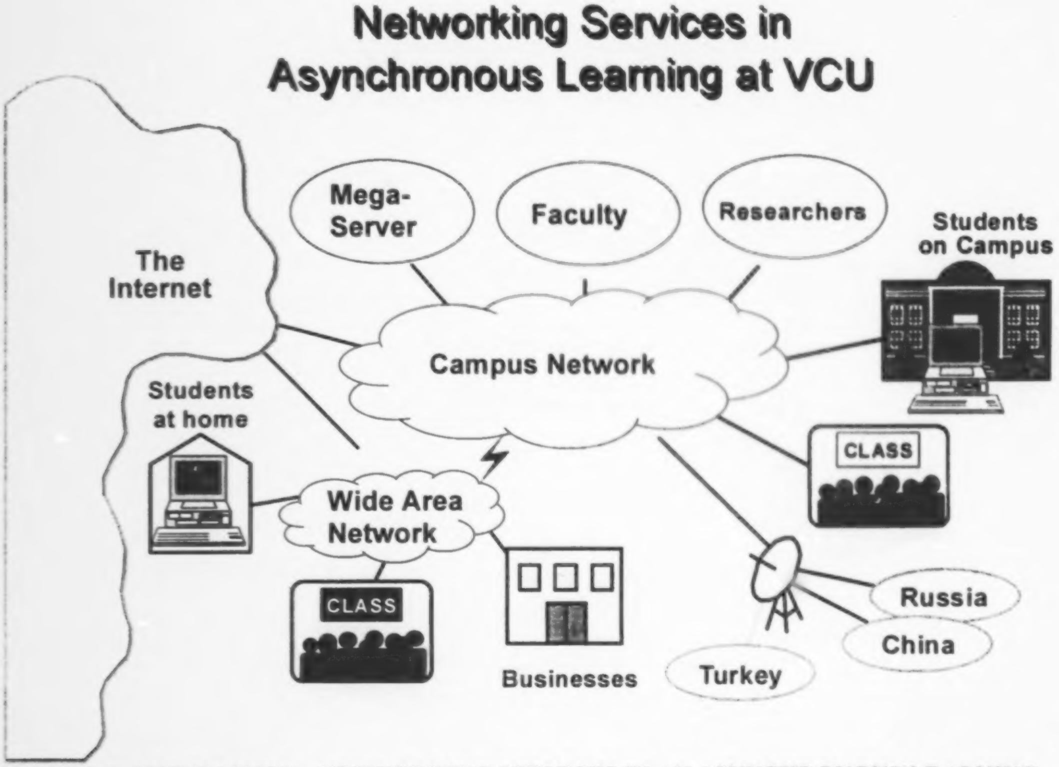

Networking Services in Asynchronous Learning at VCU
The Internet
Mega-Server
Faculty
Researchers
Students on Campus
Campus Network
Students at home
CLASS
Wide Area Network
CLASS
Businesses
Turkey
Russia
China

FIGURE 4: VCU CAMPUS - NETWORKING SERVICES IN AN ASYNCHRONOUS LEARNING ENVIRONMENT

Monitor
In a Digital Library, intellectual property is not manifest as physical items such as books, films, videotapes, etc. Consequently, compensation is not based as much on object sales as on consumer use depending upon duration, frequency, type, etc. Use must not only be controlled at the client per license agreement but also be monitored as specified in the license to ensure accurate accounting.

Authenticate
This includes two aspects: guaranteeing that the object is genuine and marking objects to prevent misappropriation. The first is accomplished via authentication servers employing both administrative procedures and technologies such as digital notarization and digital signature. Marking is achieved through use of technologies (such as watermark) that brand the object in a manner that may, or may not, be detectable by human senses and which will testify to the object's legitimacy or illegitimacy.

Watermark
One of the significant deterrents to the establishment of public on-line libraries of digital images is the concern, by the content owners, about misappropriation of their assets. In many cases, the owner earns revenue from usage of the image or

object from which it was captured. Preventing publicly-available images from being used, royalty free, is essential to the owner's business. For example, a photographic library may wish to place images of its stock on-line for inspection by potential customers, but it does not want the on-line images to be suitable for publication themselves. The Internet has become a popular advertising medium and a convenient transmission medium, but it is not secure. Many examples of this security issue will occur in the context of making images, as well as other course content, available through the Internet. A great deal of flexibility can be provided by the general technique which utilizes an image as the watermark to be applied. This image is called the watermark image. The watermark application program can make the watermark large or small, faint or obvious, depending on the preferences of the image owner.

The Digital Library is an important tool for asynchronous learning. A small but growing number of faculty are moving beyond a basic information delivery modes using Digital Library technology; they are developing a "virtual" university environment where courses and entire degree programs are delivered in whole or in part over the distributed network (Figure 4). The "virtual" environment incorporates such components as:

Online lectures and instructional materials

A networked Digital Library can incorporate hypertext, images, sound, video, animation, and the delivery of digital versions of spreadsheets, presentations, and other documents. This capability is transparent: the "download" from the networked Digital Library to the desktop occurs at the click of a button.

Interactive multimedia courses

The Digital Library allows for the creation and distribution of courses that integrate images, video and sound as well as other digital files. These courses can include hyperlinks to encourage exploratory learning, or they can remain linear-to provide more content control.

One-to-one and one-to-all communications

Lotus Notes and E-mail among faculty and students can be integrated to the networked digital library environment. *Lotus Notes* allows communication between faculty and classmates, and a Pop Mail system can be integrated for reading e-mail messages. In both cases, e-mail can include attachments of any digital file and access to remote information supplementary to the class of research. Links to the network can provide access to library resources and other academic databases that require a login sequence.

Asynchronous group communications

The primary tool for interactive dialog is provided by *Lotus Notes* or *Usenet* news/discussion groups. This asynchronous tool allows faculty to post assignments, students to submit homework, and groups to work collaboratively on projects.

Synchronous group discussions

Lotus Notes is a virtual "meeting places" where students and faculty meet both formally and informally to discuss assignments or accomplish group projects.

Online assessment

The capability of continually monitoring both the academic and technical abilities of the student can be built in, by establishing a standard query section. In some cases, all aspects of the course or program are delivered asynchronously-faculty and students never meet at the same time or in the same physical space. However, most courses today implement some combination of the tools mentioned above and components of the traditional classroom or telecourse. As the Digital Library and networking combined approach technologies become more sophisticated and bandwidth of the Internet increases, there will be more tools and more ways to develop creative distributed learning environments. In a very rief two years, the Digital Library and networking combined approach has shown that it has the potential to be the premier vehicle for distributed learning and can enable and enhance both classroom instruction and distance learning.

Convenience

Teaching and learning are not confined by space or time. Students and faculty can access the virtual classroom from their home or office. This is increasingly important to many institutions interested in drawing non-traditional students into their programs.

Updating and disseminating information

Unlike printed resources, once materials have been posted to the distributed learning network, information is easily updated and disseminated. The convenience and cost advantages of publishing information in this digital format are obvious.

Easy standardized access to other information stored in the Digital Library

Primarily available only to education, government, and research institutions a year ago, today the Internet is accessible to almost anyone with a PC, a modem, and an Internet service provider. Commercial Internet service providers are now operating throughout this country and the world. The competition to provide service is resulting in very reasonable rates in both small and large cities. Software for accessing the Internet is easily obtained either by downloading directly from the Internet or by shopping in computer stores and bookstores across the country. This easy access allows distance learners to readily access course materials from their home or office computer. And because the Internet is based on standard communications protocols, you can be certain that students accessing the Internet in Hawaii will be able to access the same resources as the students in Pacific Rim countries and the faculty in Virginia.

Currently, VCU is delivering instruction across the Internet. The Health Administration Executive Program (Master of Science in Health Administration), is the first complete degree program to take advantage of the technology described here (Figure 5). VCU will offer this program in China, Turkey, Russia, and the United Kingdom in August, 1996. The Digital Library is being implemented and radiological images (MRI, CAT Scan and Ultrasound) will be moved as objects between the Digital Library and remote locations utilizing ATM and broadband network facilities. VCU is on the leading edge in utilization of communications technology--building a "virtual" university for instruction and medical application.

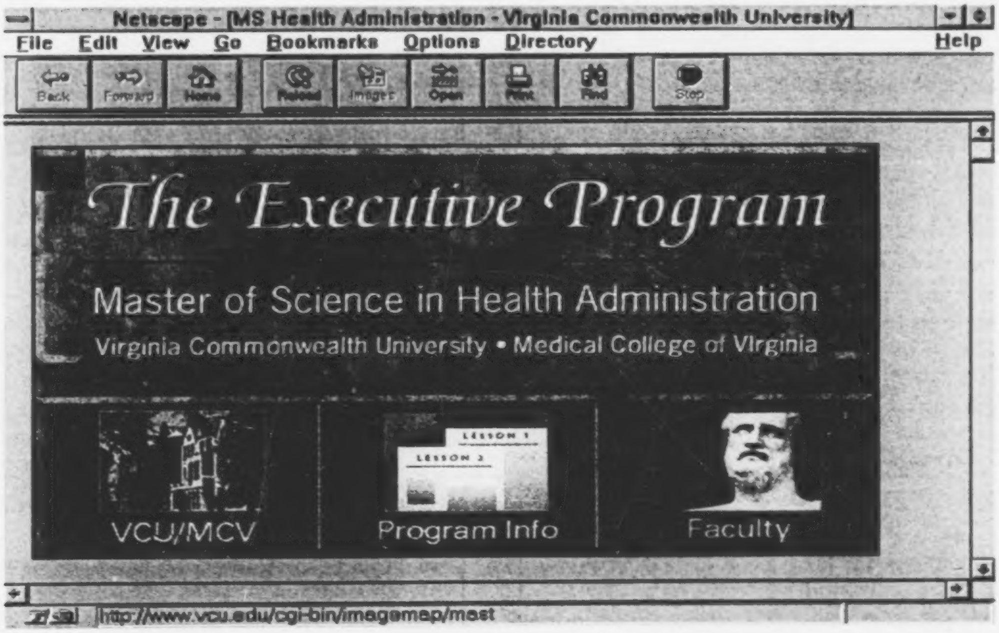

Netscape - [MS Health Administration - Virginia Commonwealth University]
File
Edit
View
Go
Bookmarks
Options
Directory
Help
Back
Forward
Home
Reload
Images
Open
Print
Find
Stop
The Executive Program
Master of Science in Health Administration
Virginia Commonwealth University • Medical College of Virginia
LESSON 1
LESSON 2
VCU/MCV
Program Info
Faculty
http://www.vcu.edu/cgi-bin/imagemap/mast

FIGURE 5: HOME PAGE FOR THE MASTER OF SCIENCE IN HEALTH ADMINISTRATION

The Impact of Wireless Local Loop Technologies in Asian-Pacific Markets

Andrew C Simpson
Teleresources Pty Ltd
Unit 2a, 4 Aquatic Drive, Frenchs Forest, NSW 2086, Australia
Tel: + 61 2 9975 2230 Fax: + 61 2 9975 2240

ABSTRACT

New wireless technology in the local loop is set to explode across the Asia-Pacific region over the next five years. Wireless connections of telephone customers to their local exchange will prove a critical factor in achieving the ambitious targets of many countries and in reducing the imbalance in telephone densities between the Asia-Pacific region and the rest of the world.

In offering an alternative to copper wire and traditional radio, wireless local loop technology will be successful because often it makes business sense. The factors driving its economic success are the cost of the competing technologies themselves, the time required to install the different technologies, telephone customer density, distance from local exchange, ease of provisioning of its main competitor, fixed wirelines, and emerging competition among wireless local loop vendors themselves.

Wireless local loop solutions will find a role across many markets including developed as well as developing countries, urban as well as rural and with incumbent operators as well as second carrier and start-up companies.

1. Introduction

The connection of telephone customers to their local exchanges is no longer restricted to copper wire or traditional point to multipoint radio. New wireless technology purpose-built for use in the local loop and downscaled cellular systems are emerging which offer flexible and affordable solutions for new customer connections.

The predictions for growth of WLL in the 1990s are dramatic and characterised by the opinion of a notable authority quoted below:

> "Wireless rather than fixed infrastructure technology will move ahead dramatically ... and a massive new product development battle has begun for the portable terminal devices to handle traffic... Wireless and convergence are the "big two" for acceleration through the mid 90s for telecomms." [1]

In the 5 year period between the years 1995 and 2000 these new wireless technologies will capture a significant proportion of the local loop market, particularly in rural villages of developing countries within the Asia-Pacific region.

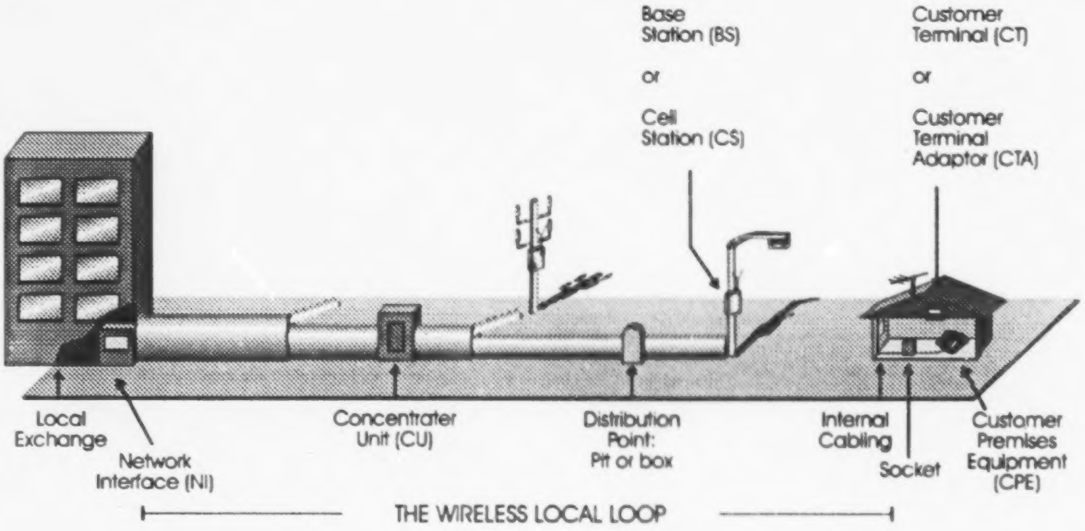
2. What is Wireless Local Loop?

Wireless Local Loop (WLL) is designed to serve the local loop or Customer Access Network (CAN) between the customer and the local exchange by radio. The Wireless Local Loop (WLL) can be distinguished from the Wired Local Loop because at least a portion of the link between the customers' premises and the local exchange is transmitted by radio. A typical configuration is depicted in Exhibit 1.

75

Exhibit 1

THE WIRELESS LOCAL LOOP


Base Station (BS)
or
Cell Station (CS)
Customer Terminal (CT)
or
Customer Terminal Adaptor (CTA)
Local Exchange
Network Interface (NI)
Concentrater Unit (CU)
Distribution Point: Pit or box
Internal Cabling
Socket
Customer Premises Equipment (CPE)
THE WIRELESS LOCAL LOOP

3. Importance of Wireless Local Loop

The future growth of Wireless Local Loop in the Asia-Pacific region will be founded on a number of its desirable features:

- Faster rollout than copper due to difficulty in laying cable in confined or congested urban areas;
- Allows early generation of network revenue which produces a higher net present value on project investment;
- Often provides a higher quality line for normal speech than fixed copper installations;
- Avoids risk of destruction of local cabling in some developing countries where copper has inherent value;
- Lower installation cost than fixed cable in many urban and rural situations;
- Lower maintenance cost than fixed cable in many urban and rural situations;
- Provides service quickly to customers where no spare capacity is available;
- Provides a mechanism to reduce the number of waiters and average waiting time to politically acceptable levels.

4. What are the types of WLL technology?

It is useful to separate the new Wireless Local Loop products into four separate categories from which new Wireless Local Loop products have developed, as specifed in ***Exhibit 2.***

4.1 Traditional Radio

Traditional Radio is a point-to-point or point-to-multipoint solution which offers telephone services in a star network topology. It is suited to low density, rural and remote environments.

Traditional radio was the first technology to be used in rural and remote areas to provide basic telephony services for both developing and developed countries. The first installations of digital traditional radio in Australia (DRCS) date back to the early 1980's.

In Australia the early DRCS system developed by Telecom Australia in conjunction with NEC has been superseded by Philip's IRT2000. Another strong contender in the area of traditional radio is SR Telecom's SR500.

Exhibit 2

Traditional Point to Multi Point Radio Systems	Purpose Built WLL Systems	Modified Cellular Systems adapted for WLL	Satellite Systems for Fixed Delivery
DRCS (NEC)	GMH2000 (Hughes)	CT2 (ETSI)	Spaceway (Hughes)
IRT2000 (Philips)	Ionica FRA (Ionica & Northern Telecom	DECT (ETSI)	
SR500 (SR Telecom	WiLL (Motorola)	PHS (MPT & RCR)	
	Qualcomm CDMA	GSM/DCS1800 (GSM MoU)	
	Other proprietary systems		

The advantage of traditional radio solutions such as IRT2000 and SR500 is that they are able to provide integrated microwave network links back to the local exchange over long distances. In the case of IRT2000 the local exchange may be located up to 1600 kilometres from the subscriber's premises. The technology is proven with numerous installations throughout the developed and developing world.

The disadvantage of radio solutions is that they have limited subscriber capacity (usually around 500 subscribers) are therefore not suitable for high or medium density situations. Radio systems do not usually offer the security of speech encryption.

4.2 Modified Cellular Systems

Modified Cellular Systems are Wireless Local Loop systems which have been adapted from cellular systems by removing their cellular hand-off capability. The removal of the mobility manager from the system allows cost-savings to be made.

Many modified systems are yet to be implemented widely in the Wireless Local Loop. GSM has only a few known cases of WLL implementation including South Africa and Fiji, while the more recently standardised DCS1800, with only a handful of networks worldwide, has no known instances of WLL installations. DECT is being trialled in a WLL configuration in several European countries and PHS is expected to be adapted for WLL applications for implementation in a number of Asia-Pacific countries.

While CT2 is being used widely in China as a technology for fixed services, the applications are limited by the need to use a dedicated handset, rather than a standard POTS telephone.

For some modified cellular systems, the rollout of WLL networks remains a promise rather than a reality.

4.3 Purpose Built Wireless Local Loop Systems

Wireless Local Loop systems, designed specifically for use in WLL applications, have no mobility capability and use directional antenna at the remote stations to allow subscribers to be located at distances remote from the base stations.

Among the purpose built WLL systems Ionica is unique in operating in the 3.4 Ghz band. Despite the need for antenna with higher gain on this band, the Ionica systems supports cell diameter of up to 15 kms.

4.4 Satellite

New satellite technologies may pose a long term threat to traditional radio and modified cellular systems. These are not specifically the much heralded LEO satellite systems, but also those satellite systems which are purposefully designing their systems to meet the needs of underserved rural populations.

A notable example is the futuristic Hughes GEO Spaceway service scheduled for implementation in 1998.

5. Product Life Cycle of Wireless Local Loop Technology

The success of various WLL technologies can be measured by their relative position on the product life cycle for WLL.

The first digital WLL technologies were point to multipoint systems which emerged in the early 1980's and fall into the "mature" stage of the product life cycle. These have become increasingly sophisticated but continue to be constrained by their low capacity and are most suited to very low density and remote applications.

Modified cellular systems such as DECT, GSM and PHS are clearly in their introductory or pre-introductory phases, while some purpose built WLL systems such as the Hughes GMH2000 and Motorola's WiLL are in the growth phase with a number of impressive installations. DECT is in the introductory stage, but has benefitted from extensive trials in Europe and reservations of bandwidth between 1880 and 1900 MHz in a number of countries. Following its widescale public launch in Japan on 1st July 1995, PHS is now being developed for use in WLL applications.

6. Relationship with Copper Infrastructure

A key factor for success in the rollout of WLL is its ability to compete against copper infrastructure. WLL's competiveness with copper is often derived from its lower cost and faster rollout in specific applications.

In terms of the cost comparison between copper and WLL, WLL is generally economical for lower density application where distance from the local exchange is greater than 3 km and subscriber density is low. As a rule of thumb, it is estimated from cost modelling that the point of breakeven between WLL and copper is reached at a distance of between 2.5 and 3.0 kms from the exchange at urban densities of 1000 km^2. Less than 2.5 - 3 kms, copper is usually preferred, but beyond this point WLL is likely to be cheaper.

A cost advantage can also be derived from the lower maintenance of WLL. Copper is expensive to maintain because it is relatively inaccessible once installed and as noted above can be tampered with by people who find it has inherent value for resale.

The accurate comparison between different WLL technologies requires a cost model which takes account of maximum allowable cell size, coverage area, number of subscribers, erlang per subscriber, frequency reuse plans, base station costs, handsets costs, and site acquisition costs.

7. Spectrum Availability

A key factor for success of Wireless Local Loop is the availablity of clean spectrum in the necessary band. Several countries such as Australia utilise the 1800 and 1900 MHz bands partly for fixed microwave links. This situation does not exclude the allocation of this spectrum to WLL technologies, but may necessitate that allocations are made on a non-interference basis only.

In some countries the plans for spectrum management are poorly defined. It seems that in this situation a key action which underpins the future success of specific WLL technologies is to make clear representations to the authorities in each country to examine the proposed allocation of bandwidth.

Another restraint is the overlap between some WLL technologies and FPLMTS (Future Public Land Mobile Telecommunication Systems) frequencies. In those countries which have a band-plan based around European allocations, an issue which may arise is that part of the bandwidth for some technologies may be withheld to allow for future takeup by FPLMTS.

8. Market Assessment of the Asia-Pacific Marketplace

The market potential for wireless local loop products in the Asia-Pacific region[2] is the highest of any region of the world. The Asia-Pacific region is densely populated where most countries are characterised by very low teledensity (ie. number of telephone lines per 100 people).

Wireless technologies are already used in some countries and driven by inherent characteristics that make them faster and cheaper to implement and more reliable than wired solutions.

8.1 Current Situation

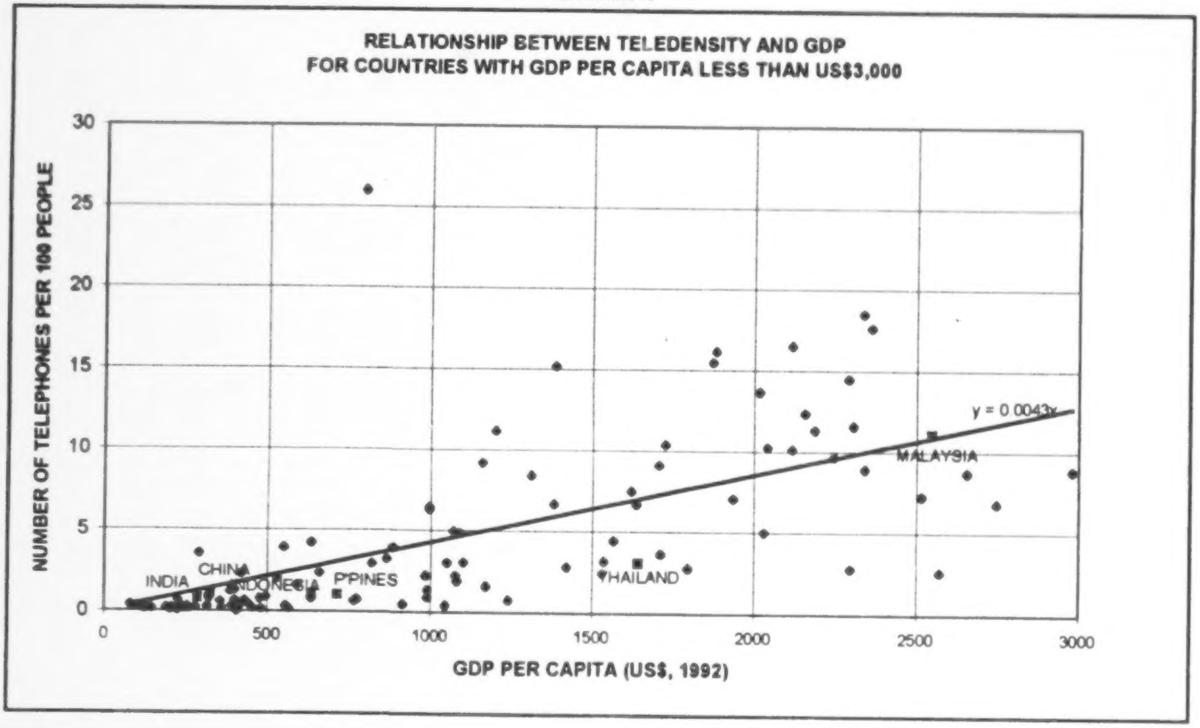
Exhibit 3

Country	Telephone Lines (mils) 1992	Telephone Lines (mils) 1994	Teledensity 1992	Teledensity 1994
Australia	8.26	8.85	47.1%	49.6%
China	11.47	27.23	1.0%	2.29%
India	6.80	9.80	0.8%	1.07%
Indonesia	1.49	2.52	0.8%	1.33%
Philippines	0.66	1.11	1.0%	1.68%
Thailand	1.79	2.75	3.1%	4.69%

Source:[3]

The Asia-Pacific region accounts for 60% of the world population (1994), but contained only 26% of the world telephone lines in 1994. With only about 170 million telephone lines serving a population of 3.4 billion, a vast number of people lack reasonable access to the most elementary telecommunication services.[4]

Exhibit 4



The development of the various markets in terms of number of telephone lines and teledensity is displayed in ***Exhibit 3*** below highlighting the gap between developing and developed countries.

For countries with a GDP per capita less than US$ 3,000, an increase of 4.3 telephone lines per 100 persons is associated with every US$ 1,000 increase in GDP per capita. The regression line of best fit is shown in ***Exhibit 4***.

Many countries have a large rural population which represents an enormous market for WLL in this market segment alone.

Most of the countries shown have 70% or more of the population living in rural areas. Non-urban people have little access to basic telephony with a rural teledensity often below 1%.

Widespread governmental recognition exists of the importance of a balance between rural and urban areas in the provision of telecommunication services. Among the perceived benefits from expanding access to communications in rural areas are:

- Decrease of population migration towards the main cities;
- Political stability;
- Sense of national identity and cohesion; and
- Social development such as health and education.

8.2 Market Applications

The following markets appear to exist for wireless local loop:

- Congested City in Developing Country
- Sophisticated City
- Village in Developing Country
- Urban Fringe Initial Rollout
- New Carrier Rollout for Suburban Areas Remote
- Homesteads and Minesites

8.2.1 Congested City

The market for WLL in urban environments of developing countries is based on the difficulties encountered in installing and maintaining a reliable telephony service based on copper infrastructure.

Both existing and new carriers are likely targets as potential purchasers of WLL in urban areas. The motive of existing carriers to invest in WLL are:

- To respond to the demands of customers;
- To avoid difficulties in "digging up the streets" in congested areas;
- To find a cheaper, faster and more reliable method of providing service to customers

In some situations spectrum availability may be an issue, notably where interference is likely to be caused by the co-siting of directional fixed microwave links.

In other markets new carriers may be a potential investor in WLL simply because the existing carrier's infrastructure cannot be relied upon to provide satisfactory service and WLL offers a quick and focussed way to rollout operations.

In India and possibly other countries the inherent value of copper may encourage pilfering.

The main factor restricting the use of WLL in these markets is its high cost relative to copper. In situations of lower density on the urban fringe or rural areas, WLL becomes cheaper closer to the exchange.

8.2.2 Sophisticated City

The "sophisticated city" is a market in the cities of developed countries based on a need to reduce waiting times and held orders for customers.

WLL may also prove to be viable as a CAN (Customer Access Network) replacement in some situations for cost reasons or where carriers wish to provide an additional option for connectivity. The trial of DECT by TeleDenmark is motivated by this thinking.

The demand from end-customers in this market is likely to be based on pressure applied to telephone companies:

- To provide their telephone service quickly; ie: reduce time spent on waiting lists;
- To provide reliable and high quality services;
- To satisfy the requirements of end-users or risk them turning to competitive carriers.

8.2.3 Village in Developing Country

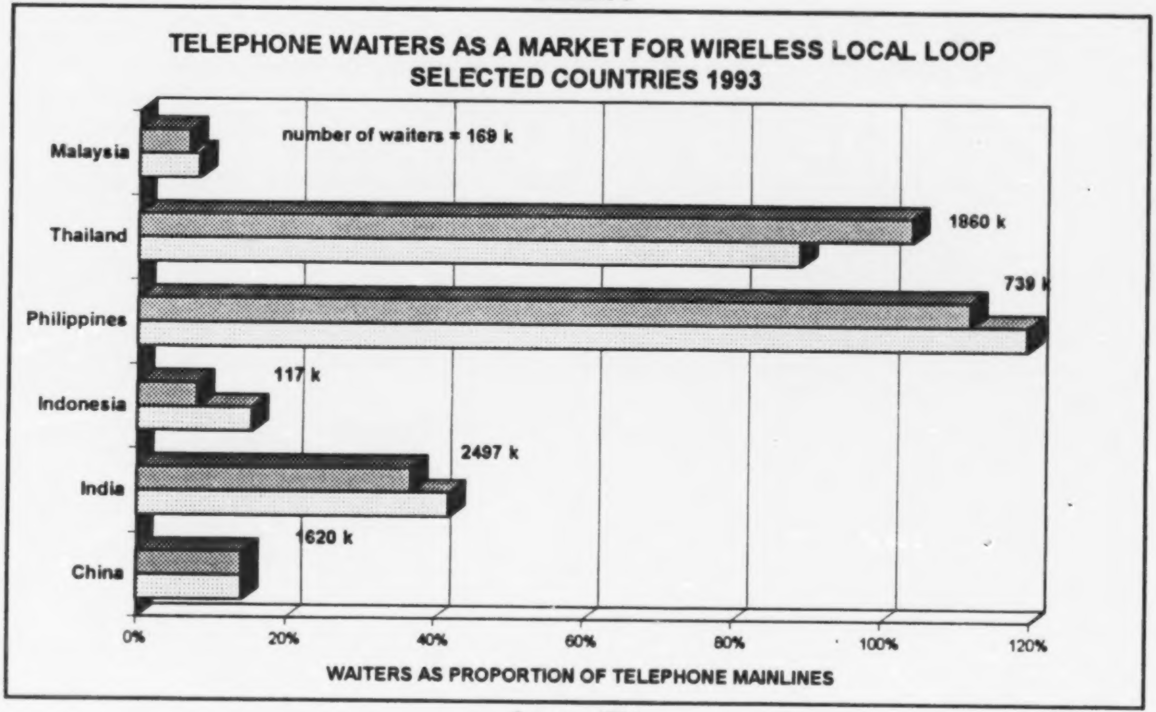
The market for WLL in rural village situations is based largely on the disparity between urban and rural teledensities noted above. In most countries a large push will be made to reduce regional imbalances in access to telephone services. The rural market is likely to comprise a combination of "push" from government and "pull" from local business and villagers.

Rural villages are difficult to serve with copper infrastructure due to its high cost in low density situations and because trenching is difficult in rugged terrain. In some areas copper may also be removed by local people for its inherent value.

Private telephone services and public payphones are likely to be required. Some private telephone services will also be used for leased payphones by shopkeepers.

59

Exhibit 5



Source: ITU

8.2.4 Urban Fringe Initial Rollout

New areas on the urban fringe of major cities which require telephone services may lack infrastructure such as trenched ducts, aerial poles, pillars and pits. A considerable delay may result before fixed wirelines can reach new areas.

This may be a problem in developed countries as well as developing countries. In developing countries, the problem of lack of infrastructure on urban fringes may be exacerbated by high population growth rates and shifting of population towards major cities.

8.2.5 New Carrier Rollout for Suburban Areas

New carriers seeking to provide telephone services to suburban areas may find WLL to be the fastest, cheapest and highest quality option available.

WLL can be regarded as a low cost/low functionality solution to provision of telephone services. At the other end of the scale is an optic fibre solution with high functionality, while copper is an intermediate solution.

8.2.6 Remote Homesteads and Minesites

Remote homesteads and minesites located more than 30 kms from the local exchange are a special market niche which can be served usually at a higher cost than other areas.

Traditional point to multi-point technologies such as IRT2000 and SR500 are often used in this market segment. Satellite delivery may also prove to be cost-effective in this segment.

8.3 Market Potential

Many governments accept either publicly or privately that state-owned networks and operators have not lived up to expectations. In general a satisfactory level of service has not been provided in terms of volume and quality, especially in rural areas. This failure can often be traced back to a lack of funds, poor borrowing ability and a low priority given to the telecommunication sectors in the past.

One area of immediate potential in the countries is obviously the unsatisfied demand, generally recorded via the waiting lists. The figure is greatly underestimated for a number of reasons. Firstly, in some countries, people may not bother to apply because of the lengthy waiting period. In 1992 the average waiting time was as long as 10 years in the Philippines. In other countries such as China and India, a deposit is required to lodge an application form. This measure alone acts to deter people from applying for a line. Finally, the number of people waiting for a telephone can be underestimated for political reasons.

However, in some countries such as Thailand, the waiting list is partly the result of inefficient procedures to connect people to existing networks. ***Exhibit 5*** shows that the longer the bar, the less efficient the connecting process.

For these reasons the waiting list reflects only a small proportion of the real potential market. The "suppressed" demand is much higher and in some countries like China, it has been estimated that the number of immediate potential subscribers could reach 4 to 5 million instead of the 1.6 million recorded by the ITU[5]. For India, the potential demand has been estimated at more than 12 million, rather than the ITU's official statistics.

Unserved rural areas constitute the biggest proportion of the population. Their needs are often different from the urban population because their incomes are lower, but the potential is enormous. A strong emphasis is placed on basic voice services and a distribution of payphones in Public Calling Offices (PCO) or other places.

8.4 Requirement for Capital Investment

The level of investment required to achieve cited national objectives in both urban and rural areas has been estimated in ***Exhibit 6***. Most objectives are for the year 2000, except for Thailand where it is for 2001. The assumptions to calculate the required investment levels include an average cost of US$1,500 per line as recommended by the ITU.[6]

EXHIBIT 6: LEVEL OF INVESTMENTS FOR 1995 - 2000 (US$B)

Country	Rural	Urban	Total
China	23	87	109
India	14	16	30
Indonesia	3	5	8
Philippines	2	5	8
Thailand	2	4	6

Sources: [7]

The capital requirements show that all these countries will require investment assistance in order to fund their objectives. Innovative technologies will be necessary to address the need of a population more difficult to access than big urban centres.

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[1] Attributed to Stephen Thomas, President, Datapro Information Services in ATUG Newsbrief, January 1995, Page 3.

[2] The Asia-Pacific region comprises countries in Asia as far east as Iran and all Pacific ocean countries.

[3] ITU, Asia Pacific Telecommunication Indicators, 1995.

[4] See ITU, World Telecommunication Development Report, 1995.

[5] ITU, World Telecommunications Development Report, 1995.

[6] ITU, World Telecommunications Development Report, 1995.

[7] Teleresources, Wireless Local Loop in Asian-Pacific Markets, October 1995.

UPDATE ON MOBILE SATELLITE SERVICES

REX HOLLIS
SPACE SYSTEM/LORAL
ARLINGTON, VA
USA

At PTC '95 I gave a report on the status of Mobile Satellite Services (MSS), and in the last 12 months there have been some substantial changes to the list of players. I am pleased to have the opportunity to review some of those changes with you.

The subject of mobile satellite service has gained a great deal of interest and credibility over the past year, aided by Inmarsat-P's joining the fray, launch of two ORBCOMM satellites and their announcement of the start of commercial service in February, progress of the Big LEOs, and the announcement of plans for mobile systems capable of operating to hand-held terminals from geostationary orbits. Regulatory issues have been on center stage, including availability of spectrum for feeder links and advancing the date for access to the 2 GHz band. All in all, it has been an exciting year for mobile service, and I feel confident the excitement will build over the next 2 to 3 years as Big and Little LEO fleets are launched and become operational.

In my previous paper, I divided the MSS providers into three groups: so called "Little LEOs", or mobile systems having no voice capability, but capable of position location and messaging; "Big LEOs", or those systems with capability of providing voice, data and fax through hand-held terminals; and geostationary satellites (GEO), both domestic and global, that can provide MSS to vehicle-mounted terminals but not hand-held terminals, and gave mention to planned GEO systems that would be capable of operating with hand-held devices. There has been substantial development in the latter since January '95, and more emphasis will be placed on that subject. However, because of the increasing size of the field, today I will limit my discussion to only those mobile satellite systems that provide communications through hand-held terminals, as summarized in Table 1.

Table 1. MSS Capable of Operating with Handheld Terminals

Constellation Type	Orbit	Service	Frequency
Little LEO	Low Earth	Data	VHF/UHF
Big LEO	LEO, MEO & ICO	Voice/Data	L & S Bands
Regional MSS	GEO	Voice/Data	L & S Bands

LEO = Low Earth Orbit
MEO = Medium Earth Orbit
ICO = Intermediate Circular Orbit

LITTLE LEO SYSTEMS, U.S.

To begin the update for PTC 96, I will first discuss status of the Little LEO programs—those that currently have FCC licenses and those that subsequently applied. While applications have been submitted for a total of eight systems, as shown in Table 2, three are worthy of specific note since ITU notification has been made for them.

Table 2. U.S. Registered Little LEO Systems

Name	Owner	Services	No. of Satellites	ITU Status**	Weight	Launch Date
E-SAT	E-SAT, Inc.	Data	6	**	114 kg	96-2000
FACS	Final Analysis Comm	Data	26	**	100 kg	96-2000
GE Americom	GE American Comm	Data	24	**	15 kg	97-2001
GEMNET	CTA Communications	Data	38	**	45.2 kg	1997
LEO ONE USA	Leo One USA	Data	48	**	124 kg	95-2000
ORBCOMM	Orbital Sciences/Teleglobe	Data	36	N	43 kg	1995/97
STARSY	Starsys Global	Data	24	N	330 kg	95-2000
VITASAT	Vol. in Tech Asst	Disaster relief medical educational	2	N	136 kg	1995

** - Information not available
N - Notified
(Data contributed by International Small Satellite Organization, 2300 N. Street, N.W. Washington, DC 20037)

ORBCOMM - Orbital Communications Corporation (ORBCOMM) a subsidiary of Orbital Sciences Corporation and Teleglobe, Inc., plans to launch a constellation of up to 36 satellites orbiting the globe at an altitude of 480 statute miles. With its first two satellites launched in 1995, it is the world's first global wireless two-way data and messaging service, offering alphanumeric communications anywhere on earth. ORBCOMM satellites will provide real time relay in the sky when in view of a gateway, and a near real-time, store-and forward system when no gateway is in view. ORBCOMM has negotiated operational licenses with nations containing more than half the people on Earth, with operating plans that include a vast array of services.

VITA – Volunteers in Technical Assistance (VITA) is a non-profit organization that initially received a license to launch one satellite into low-earth orbit, with 90 days to complete its financial showing for a second satellite. (An extension of this date has been sought.)

The FCC declined to consider a request to use a spare for a third satellite, but said it would consider such a request, along with that of other applicants, in the second round of consideration of Little LEO systems. VITA plans to use their satellite system for education, health, disaster relief, and other communications in developing countries. VITA reached an agreement with CTA in 1994 whereby CTA would manufacture and launch VITAsat-1 for the right to use half of the satellite's transponder capacity for commercial services. The satellite was destroyed in August, 1995 on an aborted LLV-1 mission, and VITA has reached an agreement to own 5 transponders on Final Analysis (Faisat) small experimental satellite scheduled to be launched in 1996 on a Russian Cosmos launch vehicle.

Starsys Global Positioning, Inc.—American Collect Localization Satellites (NACLS), received a license in November 1995 to launch a fleet of 24 satellites, and has agreed to sell GE Americom 80% of the company. (GE Americom is a second-round applicant for a Little LEO operation.) GE agreed to spend $46 million to deploy the first two satellites of the fleet.

LITTLE LEO SYSTEMS, NON-U.S.

Table 3 shows information on seven satellite systems of the Little LEO type that have been announced by other countries or regions. There is little data on the status of most of these programs, and I have serious doubt that funding will be made available for the majority of them.

Little LEO applicants that filed in the second round suffered a serious delay as a result of the failure of WRC 95 to provide requested expansion bands of spectrum.

Table 3. Non-U.S. LIttle LEO Systems

Name	Owner	Country	Services	Number of Satellites	ITU Status**	Weight	Launch Date
Courier	Elas-Courier Krompiex	Russia	Data	60	**	less than 500 kg	through 2000
Gonets	Smolsat	Russia	fax/email	36	C	250 kg	94-96
KITCOM	KitCom	Australia	Data	9	**	90 kg (ISO)	97-98
Leo One	Leo One Pan Amer	Mexico	data,fax pos det email security	12	A	150 kg	95-96
S-80 TAOS	Centre Nationale d'Etudes Spatiales	France	messages position determin	20	N	**	**
IRIS	Belgian Science Policy Office/ European Space Ag	Belgium	data messaging	2	**	250 kg	96-97
SAFIR	OHB Teledata	Germany	low speed data	6	A	**	**

Data provided by Smallspace
** - Information not available
A - Advance publication
C - Coordination in progress
N - Notified

BIG LEO SYSTEMS

Three U.S. companies have received FCC licenses to manufacture, launch, and operate a constellation of Big LEO satellites: Globalstar, L.P.; Iridium, Inc.; and TRW. The systems to be launched by these three companies are named Globalstar, Iridium, and Odyssey respectively. Action was deferred on the application of Constellation Communications, Inc., with a proposed fleet named Aries, and the application of MCH, Inc., which proposed a system referred to as Ellipso. Both have an opportunity to be reconsidered in 1996.

The term "Big LEO" is generally applied to the U.S. applicants, but could well include the INMARSAT spinoff company INMARSAT-P, or ICO Global Communications Ltd. The name is derived from the phrase "intermediate circular orbit". Data on ICO Global is shown in Table IV, along with that of the original 3 U.S. Big LEO applicants receiving licenses. These four will be discussed in detail.

GLOBALSTAR - Globalstar, L.P., the provider of the Globalstar service, will launch a fleet of 56 satellites into orbits inclined at 52 degrees to the equator, starting in 1997. There will be two launches of four satellites each, using the McDonnell Douglas Delta II, three launches of 12 satellites each using the Ukrainian Zenit 2, and one launch of 12 satellites using the Chinese Long March 2E vehicle. There will be 48 operational satellites, divided into 8 orbits spaced 45 degrees apart and containing 6 spacecraft each. The operational fleet will be at an altitude of 1410 km, and 8 spare satellites will be held in a staging orbit at 910 km. From this altitude it will be possible to replace any failed satellite in a relatively short time, even though the design of the Globalstar system provides the capability to continue uninterrupted operation with the loss of one or more satellites if they are in different orbital planes.

Globalstar ownership includes investors who were selected because of their experience in telecommunications service. These companies bring a wealth of experience and operational know-how to the Globalstar organization. Each investor has designated a number of countries for which it has have exclusive rights to provide Globalstar service, currently accounting for approximately 80 countries. It is anticipated that revenues of $1.6 billion will be realized from 2.7 million subscribers by the year 2002.

The Globalstar design features 16 spot beams from each satellite antenna, which in total results in a coverage pattern of approximately 3,000 miles in diameter. In the temperate zone, this produces overlapping coverage from two or more satellites.

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This multiple coverage results in increased redundancy and greatly reduces potential problems resulting from blockage or shading. It is made possible by the use of Code Division Multiple Access (CDMA) technology. This technology provides very high spectrum efficiency, is tolerant of many interference sources, and coherently adds multipath signals.

Globalstar will begin operation in mid-1998 with a 32-satellite fleet, with full operational status in early 1999 with 48 satellites. It is anticipated that dual mode telephones, i.e., capable of operating with a terrestrial mobile system and with Globalstar, will sell for approximately $750. Globalstar-only telephones will cost approximately $500. Exclusive service providers in each country will be able to set their own rates, therefore it is not possible to state precisely what they will be. However, since the price to the service provider will be in the range of $0.35 to $0.55 per minute, end user charges are anticipated to be less than $1.00 per minute.

IRIDIUM – Motorola, the founder of the 66 satellite Iridium mobile satellite service, will be the prime contractor and has selected Lockheed Missiles & Space Co. to manufacture the spacecraft bus. The system is projected to consist of 11 satellites in each of six orbital planes at an inclination of 86.4 degrees. The satellites will be launched by McDonnell Douglas Corp., Khrunichev State research and Production Space Center, and China Great Wall Industries. Plans call for 73 satellites to be launched, with 8 launches of 5 spacecraft per launch by McDonnell Douglas, 3 launches of 7 per launch by Khrunichev, and 6 launches of 2 per launch by China Great Wall. Initial operation is anticipated in 1998.

The Iridium design entails the use of inter-satellite links whereby satellites communicate with one another, and calls are routed dynamically from satellite to satellite, traversing terrestrial transmission only from the destination gateway to the called party. The satellites will operate in a polar orbit, at an altitude of 480 NM. The system will operate in a Time Division Duplex mode, with the space to earth and earth to space channels both operating in the 1.6 Ghz band. Modulation will by Time Division Multiple Access, thus rendering the system incapable of sharing frequency spectrum with other Big LEO operators. Under current conditions, approximately 5 Mhz of spectrum in the L-band is authorized for operation in the United States, with spectrum availability generally determined on a country by country basis for the rest of the world.

Iridium projects system cost as $3.4 billion, plus $1.3 in interest and expenses. They report equity commitments of $1.6 billion from a total of 17 investors, which include Nippon Iridium Corp., with 13.2%, and Vebacom GmbH with 10% as the largest investors except for Motorola itself, which holds approximately 25%.

Iridium telephones are projected to have an initial price of $3,000, and its alphanumeric pager to be priced at $500. Customers will be charged $50 per month for access, $3 per minute for air time, plus any interconnection charges. Charges for paging will be on a per page basis, with rates a function of the area covered. There will be a monthly access fee for paging, estimated to be $50.

Iridium plans to be operational by the third quarter of 1998 with 650,000 voice customers and 350,000 paging customers by the year 2000.

ODYSSEY – TRW Space & Electronics is holder of the third Big LEO license, and plans a constellation of 12 satellites to provide mobile satellite service under the name Odyssey. These satellites will operate at an altitude of 5,591 NM (10,354 km), a medium earth orbit, or MEO. The constellation will consist of four satellites in each of three orbits inclined to the equator at an angle of 55 degrees. Using a medium earth orbit MEO, the satellites move at a speed of 1 degree per minute, or one complete orbit of the earth every 6 hours.

TRW teamed with Teleglobe, Inc. of Canada in a limited partnership to form Odyssey Worldwide Services as operator of the Odyssey system. The general partners will provide about 15% of the equity in the venture, which is projected to cost approximately $2 billion, with projected service date in 1998. The source of the vast majority of required financing is yet to be identified.

Odyssey has adopted a beam steering technique, which permits the satellite to increase its time of coverage over land masses as it passes overhead. Odyssey claims that by pointing the antenna at the land mass as it approaches from over oceans, steering the beam as it passes overhead and departs from the land mass, it decreases the number of handoffs of in-progress calls as well as loss of capacity during the over-water journey. The projected result is an uninterrupted coverage time without hand-offs of 60-70 minutes.

ICO GLOBAL COMMUNICATIONS Ltd – ICO Global was established in January, 1995 as an affiliate of Inmarsat, with 37 signatories expressing a formal intent to invest. Over 60 communications carriers and industrial partners now make up the alliance, investing an initial $1.4 billion. First generation capital expenditure is projected at $2.6 billion, with $2.2 billion for the space segment. Inmarsat is to develop, manage, operate and market the system under contract from the ICO Global Affiliate.

Hughes is the sole source satellite contractor for the fleet, which will consist of 10 operational spacecraft plus two spares. There will be five satellites in each of two planes, orbiting at an altitude of 10,335 miles. The satellites will be large, with a mass of 2,300 Kg and DC power of 5 Kw. A complex beam arrangement is planned, consisting of 121 service links. The satellites will operate in the 2 Ghz band, using frequencies with availability advanced to the year 2000 by the 1996 WRC.

A comparison of the characteristics of four Big LEO systems is shown in Table 4.

OTHER BIG LEO EQUIVALENT SYSTEMS,

Table 4. Characteristics of Big Leo Systems

Business Characterists	Globalstar	Iridium	ICO	Odyssey
System Development Costs ($B)	1.8	4.7	2.6	2.0
Subscriber Rate Per Minute	$.35-.55 Wholesale $.55-.65 Retail	$3.00	$2.00	$.65
Estimate Subscriber Unit Cost	$750	$2,500	N/D	$400
No. of Satellites	48	66	10	12
Satellite Life (Years)	7.5	5.0	N/D	10
Launch Weight (lbs)	800	1,540-1,800	5,060	4,000
Altitude (NM)	750	480	9,160	5,600
Signal Modulation	CDMA	TDMA	TDMA	CDMA
Spectrum Sharing	Yes	No	No	Yes
Path Diversity	Yes	No	Yes	Yes
Gateway	C-Band	New KA-Band	C-Band	New KA-Band
Planned Service Date	1998	1998	2000	1998

N/D = Not Disclosed

NON-U.S.

Additional MSS systems, capable of voice communication, are shown in Table 5.

Table 5. Additional Non-U.S. Systems of MSS Voice Service

Name	Owner	Country	Services	Number of Satellites	ITU Status **	Weight	Launch Date
ECO-8	Embratel Telebras	Brazil	Voice/fax position determin.	8	A	--	1998
MiniSat	INTA Inst. National de Tec Aero	Spain	Communication voice/data	2	--	150 kg 500 kg	97-98
Signal	NPO Energia	Russia	Voice data	48	--	--	--

** Information not available
A Advance publication

MOBILE SATELLITES FROM GEO

The idea that it would be possible to communicate via a handheld transceiver with a satellite located 22,300 miles away violates the intuition. However, it is a technology that is rumored to have been developed for classified applications within the government, and is rapidly being applied to commercial applications. To understand this technology consider that a transmission link can be maintained when there is a loss in transmit power or receiver gain at one end of the link, it is offset by an increase in power and receiver gain at the other. A reduction in the size and power of the handheld user terminal is offset by use of a very large antenna on the satellite. Three examples of this application have recently emerged in the form of regional MSS systems planning for GSO operation. The characteristics of each are presented in Table 6.

Table 6. SS Providers from GEO

Business Characteristics	Asia Pacific Mobile Telecom (APMT)	Afro-AsianSatellite (ASC)	Asean CellularSystem (ACES)
System Development Costs ($M)	$650 M	$800 - 900 M	$600 M
Primary Backers	- China Aerospace - COSTIND (China) - Singapore Telecom - Singapore Technology	- ESSEL Group (India) - New Corp (Australia)	- PLDT (Philippines) - Pacific Saleit Nusantara (Indonesia) - Jasmine (Thailand)
Coverage	China & SE Asia	55 Countries in Africa, ME, Former CIS, Asia and India	SE Asia, Indonesia, Philippines
No. of Satellites	2	2	2
Prime Contractor	In Competition - Hughes, Loral	Hughes	Lockheed-Martin
Launch Life (Years)	12	12	12
Signal Modulation	N/D	TDMA	TDMA

ASEAN CELLULAR SATELLITE SYSTEM (ACES), OR GARUDA

Partners in the Indonesia-based ASEAN Cellular Satellite System (ACeS), a geostationary satellite system, capable of providing voice communications to hand-held devices, include Jasmine International Public Co. Ltd. of Thailand, the Philippine Long Distance Telephone Co., and PT Pasifik Satelit Nusantara of Indonesia. Two satellites will be manufactured by Lockheed-Martin Corp., with the second to serve as a ground spare. Satellite capacity was announced as 10,000 simultaneous calls. Coverage will include India, Thailand, the Philippines, Indonesia and Japan.

AFRO-ASIAN SATELLITE CORPORATION (ASC), OR AGRANI

Afro-Asian Satellite Corp. (ASC), a proposed regional mobile satellite service backed by Essel of Bombay, is designed to provide service to 55 countries. Coverage is projected to include parts of Africa, the CIS, Asia,

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and the Middle East. Hughes will manufacture the two satellites for ASC.

ASIA PACIFIC MOBILE TELECOMMUNICATIONS OR APMT

The Asia Pacific Mobile Telecommunications (AMPT) system is 25% owned by Singapore Telecom and 75% owned by Chinese agencies. Regional coverage will focus on China. The manufacturer for these satellites has not yet been selected.

RELATIVE MERITS OF LEO AND GEO MSS SYSTEMS

While it is conceivable to cover the low to mid latitudes globally with a family of regional GEO mobile satellite systems, their strength rests with a regional concept. These could include:

- earlier to market
- easier to obtain licenses
- beam shaping permits continuous use of full system capacity
- simplified satellite control
- longer life

Since there are different characteristics among the four LEOs, Globalstar will be used for comparison. Its advantages over GEO satellites systems include:

- Greater redundancy, providing multiple satellite access and coverage in case of a spacecraft failure
- voice quality (imperceptible delay)
- near global coverage
- handset portability
- fewer dropped calls (diversity, better look angles at higher latitudes)

CONCLUSIONS

WRC 95 was very kind to the Big LEO satellites in that it provided frequency spectrum for feeder links to gateways, and in the case of ICO, communications channels between user terminals and the satellites. It was not so kind to the latest group of Little LEO applicants, for no new spectrum was allocated—though there is reason to believe this will be corrected with WRC 97.

With the enabling spectrum now available, there is ample reason to believe that at least three of the Big LEOs will complete and launch their systems—Globalstar, Iridium, and ICO. Odyssey continues as a strong possibility, but as of this writing, there is no indication that financing has been arranged. With addition of each MSS system, the financing problem becomes more difficult for those that have not yet obtained necessary funding, as is the case of the two applicants that did not receive their license in 1995, Ellipso and Aries. They are eligible for review in January of 1996.

With three regional systems and at least three Big LEOs, the question of the market's ability to sustain them all is frequently asked. Only time will tell, but there are untold millions of potential users, and new applications will quickly evolve once the communications channel is made available. One thing is abundantly clear, the world is about to find a new way to communicate, and we are in for a fascinating marketing battle.

Wireless in Indian Railway Telecommunication Network

Mohan Kishen Kaul, Former Telecommunications Advisor, Ministry of Railways
D. Swaminathan, Director Maintenance Lines, Department of Telecommunications
B. A. Majmudar, Vice President India Operations, QUALCOMM
New Delhi, India

1. Abstract

The paper discusses the use of code division multiple access technology for the linear captive network of Indian Railways. The technology in addition to being cost effective could cater to both fixed and mobile environment of railways.

2. *Wireless in Indian Railway Telecommunication Network*

2.1 Railway Telecommunication network requirements

2.2 Introduction

Indian Railways own and operate a large telecommunication network next only in size to PSTN network. The Rail network cirss crosses length and breadth of the country and forms the backbone of the national economy. The Management function of this fourth largest Railway undertaking in the world under one management is performed by a large telecommunication long haul microwave network. For day to day train operations, the system uses millions of kilometres of copper wire along the track mostly for voice circuits in omnibus mode with selective calling facility. These omnibus control communication circuits extend to a maximum length of 200kms with a typical range of 120 to 150 kms. A section controller normally mans the link with tapings at twenty to thirty wayside stations and other nodes. A block working circuit for fail safe train operation is also carried on the same alignment.

2.2 Limitation of present technology

Open wire lines are difficult to maintain due to inhospitable terrain, frequent breakdowns due to vegetation coming in to contact with these lines and their proneness to lightning and other electromagnetic interference along the electrified tracks Screened quad cable used in the electrified areas though an improvement to take care of difficulties mentioned above is still prone to vandalism, thefts and natural calamities like floods, landslides etc. Leading to high maintenance cost. Railway network though presently being addressed as a fixed network does need to be upgraded to cater to the mobile environment also.

2.3 Network Design and costs

The network design assumes a hypothetical control section of about 150 kms from station "A" where the main Railway control office is located to a station "B" with a control subsection between station "A: and "C". The distance between "A" & "C" could be about 50 kms with 8 intermediate stations. The section controller at "A" need to be in constant touch with all the stations in omnibus mode and with selective calling facility.

In a typical Railway environment about 3 to 4 control circuits are provided in non electrified area and about a dozen in electrified territories. It will thus need more number of code sets to cover all the control circuits.

The conventional overhead alignments used by the Railways constitute a staggering figure of millions of kms. These are very old copper based and new alignments are ACSR(Aluminium conductor steel reinforced) based owned and maintained mostly by Railways. These suffer from very poor operating efficiency, high maintenance costs and in any case have to be replaced by quaded cable when routes are electrified.

With copper costs going up, Railway administrations are looking more and more to optic fibre where O & M costs per channel are much lower. The operating efficiency of overhead open wire circuit could be as low as 15% but rarely exceeds 60-70% this is matched by its low construction costs at about Rs. 0.1 million/km. ($ 3200/km) The annual recurring maintenance costs amount to about 5% of the total erection costs. In electrified areas the quaded cable of size 0+17+3 is mostly used and the efficiency figure achieved could be as high as 95% to 98% with construction cost varying between Rs. 0.5

million to Rs. 0.7 million/km. ($ 16000 to $ 22400/km) The network does not include any mobile communications for Railway operation. In optical fiber territory the costs vary between Rs.0.9 million to Rs.1.1 million per kilometres ($29000 to $35000).

IR has tower mounted 18GHZ based point to point operating control circuits since 1980's. These systems are used mostly on Eastern Railway running along the Gangetic plain where the tower hights re reasonable although rainfall rates are quite high. However use of this technology option is restricted by terrain, rainfall rate and can not be universally used on all routes. The system cost varies between Rs.15 million per km to Rs.20.0 million per km($48000 to 6400). The O.F. and 18GHZ options include provision of a simple mobile emergency communications system.

3.0 Technology Options

Railway Network is suffering from considerable technical and operational constraints due to the existing technology in use. In addition IR is facing funds constraint for modernising the network. Hence it becomes necessary to look out for technology option which provides technical solutions to operational problems at an optimum cost.

3.1 Point to Multipoint Wireless technology provides optimum solution enabling an integrated approach for railway administration's catering to both fixed and mobile communication environment. With the inherent advantages that digitisation of communication offers, FDMA option is not considered a suitable solution.

3.2 Wireless in the Indian environment needs very careful planning due to lack of regulations on generation of manmade RF noise. IN addition for a wireless user like IR there are considerable areawise restrictions on the allocation of frequencies. The environment in which the communication is to take place is basically on a multipath mode leading to Raleigh type fading. The security requirement for information particularly for Block Working is very sever and hence needs proper error control mechanisms. Any system that is introduced in the railway network should have a considerable technology life so that a long term perspective can be evolved while planning the network.

3.3 Considering all the above aspects, is found that performance as claimed by CDMA technology is far superior to the TDMA option.

3.4. CDMA Option

CDMAoffers the following advantages :

- Large capacity. CDMA has much larger capacity than other wireless technologies, which makes it possible to serve many more subscribers in a switching Centre from a centralised sectored base station.
- More range. CDMA provides considerably more range for a given amount of power.
- No frequency planning. a CDMA system requires no frequency planning or returning when it is first set up or when it is expanded in response to unpredictable demand. Less power per call. CDMA wireless stations limit their transmitted power to only that required for reliable transmission. Power control extends battery life in portables and in fixed stations on standby power, increases the capacity of the system by minimising interference to other calls, reduces subscriber equipment cost, and minimises concerns about the biological effects of radiated power.
- Natural service evolution. CDMA allows system to evolve naturally from straight wireless replacement of wire-based loops to the full mobility and service capabilities of PCN Flexibility. The high degree of flexibility of CDMA-based wireless systems allows to select and architecture that meets needs and the needs of your subscribers. This flexibility applies both to the degree of equipment centralisation required, as well as to the level of subscriber mobility needed.
- Equivalent cost. Currently, CDMA per-loop cost compare favourably to those for wired loops. However, as the technology evolves, the cost of CDMA equipment can be expected to decrease dramatically in much the same way the cost of personal computers had decreased. In contrast, wired loops can only increase in price.

3.4.1 COSTS

Field trials have shown than the capacity of a static CDMA system assuming an average busy hour average per subscriber of 0.1 Erlang, up to 400 subscribers per sector per 1.2 5MHz bandwidth channel can be served. The configuration given at para 1.3 will need one channel (one code) in CDMA with parallel tapping at each station. For a typical coverage of a control subsection of about 50-60 kms a base station will be set up at control office at station "A". All wayside stations will be provide with handsfree telephone. A set of code with complimentary TX, RX need to be provided at each station so that track maintenance personnel will be in touch with the nearest station through hand held sets.

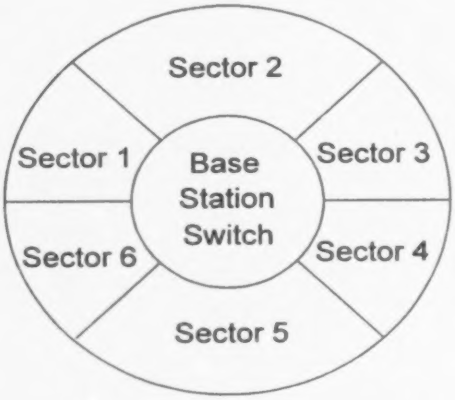

Figure 1: A Basic CDMA Wireless System

Assuming six sector and availability of ten 1.25 MHz channels in each direction the total capacity of a CDMA Base Station is up to 2400 subscribers.

Assuming that number of stations in a Control Subsection of 50kms is 8, and each station has a compliment of three reservation Counters, one PSTN/Railway phone, I Public call office in addition to other operational points and portable hand held sets with Patrolmen / Maintenance staff per block section to be an average of 3, the total number of CDMA phones will be about 72. Taking the average cost per subscriber to be about $1200, and catering to about 12 control circuits operational in electrified territory the average cost of a CDMA set up for a Control Subsection of 50 kms works to about $108,0000 roughly about Rs.3.0 million with maintenance cost at about 1%. A train to control mobile communication system is available at no extra cost and with possible connectivity to PSTN, CDMA option could be a strong contender for Railway Telecommunications specially in electrified areas where copper or optic fibre is being traditionally used.

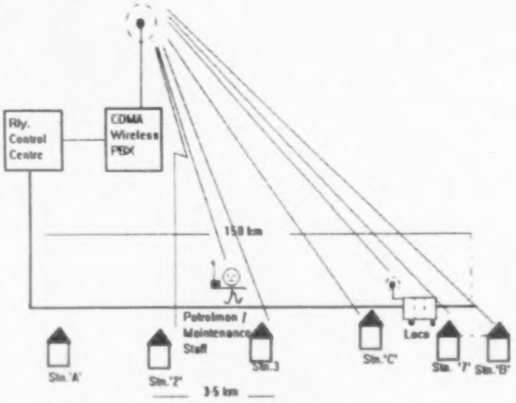

Figure 2: Railway Telecommunication Network -CDMA- Fixed & Mobile Integrated Option

4. Conclusion

CDMA network can provide both fixed and mobile communication requirements of Indian Railways with more options and features compared to the cost of this kind of a CDMA network, even the least cost option of copper pair, for fixed application alone, would cost more than double this amount. Indian Reilways could consider their technology options for their long haul, short haul point to point and point to multipoint network to mke it cost effective and reliable.

M.K. Kaul
Consultant, Former Telecommunications Advisor, Ministry of Railways, C-27 Pamposh Enclave, New Delhi - 110 048, India.

D. Swaminathan
Director (Maintenance Lines), Department of Telecommunications, Sanchar Bhawan, New Delhi - 110 001, India.

B.A. Majmudar
Vice President (India Operations), QUALCOMM International, Suite 510, The Oberoi, Dr. Zakir Hussain Marg, New Delhi - 110 003, India.

WIRELESS INFRASTRUCTURE IN VIETNAM:
evaluating an emergent leapfrog strategy

A Lee Gilbert, Director
MBA (Management of IT) Programme
Nanyang Business School, Singapore

1. ABSTRACT

Wireless telecommunications is an infant industry in Vietnam, which promises to be an effective solution to rural and urban needs for connections. However, success will require substantial investments in infrastructure by overseas sources of capital and technology, and new working relationships between foreign investors and those local organisations able to bring the political and organizational resources needed for a viable long-term venture.

Vietnam's ASEAN entry is an opportunity to review telecommunications policy. An aggressive government could help strong local partners attract the technological and management skills needed to help develop markets, build manpower resources, and put effective operations in place. This paper explores interactions between demand and supply in the context of the interests of the key actors, and applies the scenario analysis technique to identify likely development issues for stakeholders in the rapidly growing sector.

2. INTRODUCTION

Telecommunications is difficult in Vietnam, as in any narrow mountainous coastal nation of 329,560 square kilometers sustaining the vast majority of its 75 million population in rural towns and villages(1). Demand increased following the Doi Moi policy movement of Vo Van Kiet, which shifted the nation from its centrally planned to a market economy. New measures to separate regulation from service delivery and decentralise local operations attracted foreign capital to the sector. The payoff was rapid introduction of new technology and accerated line capacity growth. Today, its national system offers 100% digital switching and transmission in cities and among major exchanges. However, even this improved network infrastructure is inadequate to meet rising demand, and current thinking is to use advanced technology to optimize the value of its limited physical network capacity. In rural areas, breakthroughs in low-cost digital technologies may extend network reach at a moderate cost. In cities, mobile services can support a faster business pace.

For overseas suppliers, planning is hampered by lack of data and uncertainties. However, there is substantial scope for mobile equipment and service sales, which should continue to grow very rapidly over the next decade. Gaining access to emerging service markets demands substantial investment of capital and scarce skills, plus developing a sound working relationship with a local organisation able to bring the necessary organisational and political resources into a successful long-term venture.

The industry is now very volatile, and many foreign players court the few local organisations capable of seeking approvals and operating a complex system. New operators experience difficulty in providing an adequate service level while meeting rising demand. Regulators, coping with the rapid transition to a liberalised policy regime, struggle to develop new legislation to govern the sector and meet rising expectations. Foreign suppliers enter with caution any relationship governed by a contract executed in an emergent commercial legal system. New entrants seeking to mitigate such inherent risks must select a partner with compatible interests, then formulate market entry and development strategies which will be robust in all likely future contexts. Scenario analysis, discussed in a later section of this paper, is a useful planning tool for evaluating such complex entry mode and policy options.

2.1 DEMAND FACTORS

Although official per capita GDP is less than US $300, actual purchasing power is perhaps four times this. Average income in major cities is far higher and is rising rapidly (2). Cellular service users exceeded 8,000 at end 1994, and in 1995 their ranks grew at nearly one thousand units per month. Pager use is doubling annually. Current demand for wireless services stems not only from urban subscribers using carphones, handphones, and pagers for better access on the move, but those using handphones as an interim substitute for a fixed telephone line, and rural residents using fixed wireless as a link to the nearest district exchange.

Southeast Asia

CHINA
Hong Kong
Hainan Dao
THAILAND
VIETNAM
South China Sea
PHILIP
Andaman Sea
MALAYSIA
Borneo
Sumatra
Java Sea
Java
INDO
Indian Ocean

Source: CIA Fact Book 1994

The Socialist Republic of Vietnam is a narrow coastal nation separated from its neighbors by mountains and the sea, sustaining only a small minority of its population in urban areas. In these cities, restricted Post & Telecom (P&T) land line capacity is a transient source of demand for cellular services. However, a younger generation perceives the handphone less as a convenient status symbol than as a normal means of staying in touch. Digital pager use is growing rapidly, and many users may upgrade to handphones as these become affordable.

Table 1 below depicts major urban areas, estimated population (varying from official figures), telephone lines per capita, handphones in use in mid-1995, and the estimated growth rate in handphone use (3).

TABLE 1: MAJOR URBAN MARKETS

Areas	Population	Teledensity	Handphones	Growth rate
Hanoi/Haiphong	5 m	3.4/100	3,800	200/mo
Ho Chi Minh	6 m	3.2/100	12,800	500/mo
Danang/Hue area	3 m	1/100	0	50/mo
National	**7 5m**	**0.9/100**	**16,600**	**750/mo**

The Vietnamese government targeted the year 2000 as its deadline for providing telephone services to all its villages. Demand for fixed wireless stems from the conflict between the low revenues to be gained by providing services to outlying villages, versus high initial and maintenance costs to string twisted wire to low-density rural areas. Small-scale rural wireless service trials have shown promise in Malaysia, Indonesia, and India. Several foreign operators are now gaining experience in field trials.

Even for experienced foreign operators, wireless market entry will not be simple. A new entrant, well-armed with access to advanced technological skills and capital, must still be able to select the right technology, develop local markets, attract strong local partners, and help their local partners put effective operations in place. Success demands an understanding of the rapidly evolving structure of the telecommunications policy environment.

2.2 THE TELECOMS POLICY ENVIRONMENT

Sector regulation falls under the Directorate General of Post & Telecommunications (DGPT), which relinquished responsibility for operations to state-owned Vietnam Posts and Telecommunications (VNPT) in 1990. DGPT is responsible for national policy, frequency management, and technical standards, carries out R&D in support of its policy research, and also oversees all telecommunications-related business cooperation contracts (BCC) and joint-venture (JV) manufacturing. State-owned VNPT operates the national backbone network interconnecting the 53 provincial operating companies, over which it has substantial influence. Separate VNPT subsidiaries provide domestic long-distance (VTN), data (VDC), and international services (VNI). The traffic growth rate exceeds 75%, despite high tariffs for overseas calls, which are the major source of VNPT revenues. Links to overseas Vietnamese generate much of this traffic.

A national Law on Posts and Telecommunications is promised. In the interim, DGPT regulation of the sector is apparently conducted on a case-by-case basis. The current national mobile communications standard is GSM, although the Ho Chi Minh City P&T plans a trial project for digital AMPS, and CDMA technology is under review by DGPT.

DGPT is responsible for setting technical standards, although the decision path for controversial issues leads to the Communist Party Political Bureau (which provides conceptual direction) then through the Prime Minister's office, which examines economic issues and prepares implementation guidelines. In early 1995, more than ten major telecommunications projects were under such review. Several wireless trial projects, involving NEC, Hughes Network Systems and AT&T, are underway. Trials provide valuable experience with new technology and help substantiates competing claims of lower costs, performance advantages in noisy environments, and superior security features.

2.3 SUPPLY ISSUES

Driven by accelerated business velocity and rising prosperity, wireless capacity grew after the opening of the economy in the late 1980s. While Vietnamese law does not yet allow wholly foreign-owned firms to operate telephone networks, several contract joint ventures (governed by Business Cooperation Contracts, or BCC) provide various services. The Australian carrier Telestra, with an investment approaching US$ 250 million, is a major player. To capture the emergent demand for an international gateway, Telestra linked up with VNPT in 1986, installed an earth station and other infrastructure for less than one million dollars, then reinvested its profit in backbone network projects. Despite this, the authorities may not allow Telestra to expand its current business scope to the wireless arena (4).

While the 53 semi-autonomous provincial P&T units are technically equal, the Ho Chi Minh City (HCMC) P&T is visible due to its large scale and the dynamic economy of the South in recent years. HCMC P&T sponsored a wide variety of new technology-based services, implemented as field trials. After DGPT acted to discourage this practice, certain HCMC-based joint ventures experienced difficulty in obtaining the licenses needed to expand to adjacent markets. In practice, Hanoi-based local organisations such as VMS have significant advantages in gaining market access.

2.4 MARKET ACCESS

Gaining access to wireless telecommunications service markets in Vietnam requires meeting four major conditions: adequate financing, appropriate technology, access to national infrastructure such as the radio frequency spectrum, P&T network, radio towers, and underground cables, and a local partner with the appropriate political and organisational assets to sustain project approval, implementation, operation, and expansion over the life cycle of the venture. A foreign operator is expected to package the first two elements, and to team up with a local organisation with the latter. Political influence is the primary means of rivalry for important resources such as frequency allocation, key staff, and capital.

Allocation and management of radio frequencies for mobile operations involves the DGPT and the local P&T organisation. Frequencies are allocated only to Vietnamese organisations, and through them, to ventures with foreign partners. Investment laws allow holders of frequency licenses to represent such allocations as leasing assets making up part of their capital contribution to a joint venture.

Equity joint ventures are permitted for equipment production, but all service delivery must be carried out through Business Cooperation Contracts (BCC). In practice, a BCC amounts to a contract joint venture, which must be approved by DGPT and the State Committee for Cooperation and Investment (SCCI), then implemented in an emerging legal system where commercial law is at best difficult to enforce, and political clout is likely to impact the workings of the legal system. While national security and political sensitivity are often cited as the justification for the restriction to the BCC mode for telecommunications services, its side effect is to constrain the legal rights of foreign partners. However, the Telestra case illustrates mutual gains from a well-structured joint venture, with a multi-million dollar commitment governed (until recently) only by a memorandum of understanding (MOU) and carefully aligned interests.

DGPT and VNPT regularly solicit proposals. For example, in early 1995 VMS considered four total network solutions, each with a different partner. After developing a business relationship with a local partner, the next step for a foreign supplier is to obtain project financing. Once this is secured, technology can be specified or approved, and the local partner completes the licensing process, which should already be informally agreed.

3.0 CURRENT INITIATIVES

The leading wireless operator, government-owned Vietnam Mobile Services (VMS), received the first nationwide license for wireless telephone services on the GSM 900 band, and implemented a network based on Ericsson technology in the Ho Chi Minh City region. VMS also took over an Alcatel-based network (with which they seem to be experiencing operational service quality problems) from the Hanoi P&T. Now directly under DGPT, and no longer an arm of VNPT, VMS is dependent on its links to local P&Ts, and also appears to remain strongly influenced by VNPT. VMS and its new Swedish partner Kinnevik plan to expand services throughout the country. Other government-linked companies, such as SIGELCO, have similar plans.

Rural networks serving the Vietnamese population living in rural towns and villages are fashioned from a mixture of copper cable, obsolete switches (often used PBXs), and low-capacity (often analog) microwave links. Two years ago, one in ten rural villages had telephones: now, seven of ten villages in highland areas, and one in ten mountain villages are linked. Rural phone density is about 10% of that in urban areas. By the year 2000, the policy target is telephone service to every village, a goal shared with Indonesia and India. However, these nations have a significant head start, and Vietnam is exploring the potential role of wireless technologies to help meet this self-imposed deadline. Rural areas will contain only 70% of the population by the year 2000, when policymakers hope every village will have an exchange of 50 to 100 lines. In more populous areas, such exchanges will be linked via PCM cable or low-capacity digital microwave. In difficult terrain such as the Mekong delta and the mountains, the current plan is to use HF radio links to connect villages with district-level exchanges, then to replace high traffic HF links with digital MARS systems over the next five years. Remote areas with concentrated populations will be served by 1.5 to 3-metre VSAT technology. Dispersed populations can be served by small radio systems.

While wireless solutions were once prohibitively capital-intensive (early pilot projects in rural Vietnam exceeded $2,500 per line), the government is committed, and emerging digital wireless technologies can bring costs per line below $1,000, comparing favorably with wire (5).

The rural design features digital switches from India's Centre for the Development of Telematics (C-DOT). An integrated RAX switch-cum UHF radio transceiver kit developed at the C-DOT Bangalore facility, is shipped in semi-knockdown form (6). 20,000 RAX lines, mostly funded through soft loans from the Indian government, are now in place. The DGPT Research Institute for Posts and Telecommunications provides maintenance, and also assembles and tests the C-DOT 10-channel radio link currently deployed. SR Telecom and Phillips TRT dominate the rural point-to-point microwave market. DGPT and Phillips formed a joint venture to produce the IRT 2000 TDMA multi-access radio system. Alcatel, Ericsson, and NEC provided technology for rural wireless local loop trials near Ho Chi Minh City and Hanoi.

In 1993, VNPT entered into a $110 million outsourcing project with a New Zealand firm to provide rural wireless connections to 5,384 villages and towns throughout the nation by the year 2000. Telenz International (a TCNZ subsidiary) conducts equipment trials, screens vendors, and will soon install, manage, and operate rural links. Their design relies heavily on radio technologies for trunk, junction, and local loop applications. Villages and towns of more than 50,000 population are the initial target. Field trials of rural wireless technologies sourced from regional suppliers Marine Air and Exicom are underway (7).

In urban areas, rising incomes drive demand for telephone service, and a faster pace fuels new demand for mobile service. Paging services are a rapidly growing market segment. Subscribers double yearly: from 60,000 today, they may reach 300,000 by the year 2000. Table 2 profiles the pioneer Hanoi and Ho Chi Minh City operators.

TABLE 2: PIONEER PAGING SERVICE OPERATORS

OPERATOR	ENTRY	INVESTMENT	SUBSCRIBERS	SERVICE AREA
Phone-link	1992	about $1m	18,000	HCMC, Mekong Delta, Vung Tau
Saigon **ABC**	1993	about $1m	8,000	HCMC, Hanoi, Mekong Delta, Haiphong
Saigon-**EPRO**	1992	about $1m	8,000	HCMC, Mekong Delta
MCC	1989	less than $1m	3,000	HCMC

3.1 CELLULAR TECHNOLOGY IN USE

Cellular mobile services are GSM-based, except for the problematic Call-Link trial, soon to migrate to D-AMPS. The Saigon-based Call-Link service has been unable to obtain approvals from VNPT to move beyond the borders of Ho Chi Minh City Post & Telecoms, and was forced to retreat from plans to expand AMPS coverage via new repeaters sited in Vung Tau and the Southern growth region.

The table below describes several companies currently operating in urban mobile markets.

TABLE 3: PIONEER MOBILE SERVICE OPERATING COMPANIES

OPERATOR	ENTRY (Source)	INVESTMENT	SERVICES	SERVICE AREA
Call-Link	1991 (Singapore)	13 million	AMPS (Ericsson)	HCMC
City-Net	1992 (Singapore)	3.2 million	2-way radio, CT2	HCMC, Vung Tau:
VMS I	1992 (Vietnam)	10 million	GSM (Alcatel)	Hanoi (4/1993)
VMS II	1994(Vietnam)	13 million	GSM (Ericsson)	HCMC region
VMS-CIV	1995 (Sweden)	350 million	GSM (Ericsson)	Hanoi, HCMC, Danang

3.2 RESOURCE ACCESS

Once in operation, the key tasks are to capture market share and deliver quality services. While the marketing practices of current operators are relatively straightforward, the arena will heat up as players gain experience, driving competition up, and margins down. Over the near term, the capital needed to meet rising demand will be a severe constraint, as a recent digital mobile forecast for the Ho Chi Minh City area indicates, in table 4 (8):

TABLE 4: PROJECTED INVESTMENT TO MEET HCMC-AREA DEMAND FOR MOBILE TERMINALS, 1995-2010

	end-1994	**end-1995**	**1996-2000**	**2001-2010**
TERMINAL USERS	5,000	15,000	85,000	470,000
CUMULATIVE INVESTMENT	US$10 million	US$25 million	US$55 million	US$113 million

Access to infrastructure will be another major growth barrier. At present, operators with weak linkages in Hanoi have difficulty obtaining access to tower space, underground cabling, frequency allocations, and other key resources, while those with stronger connections find it less far difficult.

DGPT has allocated frequencies to more than forty commercial applications. While its frequency allocation practices follow international guidelines, there are cases of unlicensed spectrum use which the government has not until quite recently been able to detect and enforce due to a lack of sophisticated monitoring equipment. Various military units, police agencies, and various units of the Communist Party have acquired and continue to control significant portions of the spectrum.

3.3 OPPORTUNITIES FOR SUPPLIERS

Even though the BCC legal mode for service operations is prescribed, market entry remains an open choice. The alternative approaches available to a foreign equipment manufacturer include:

1. *Offering specialized equipment to meet needs in a specific market niche.*
2. *Joining another foreign supplier to offer high value-added components to a total national network solution.*
3. *Joining other foreign suppliers to offer a total network solution, while committing to local production and training.*
4. *Making a long-term commitment to Vietnam's development, and putting a portion of the necessary institutional framework in place, as an integral portion of its market development.*

These modes differ significantly in terms of commitment and scope for strategic long-term development. The first option consists of little more than trading, while the latter offers scope to initiate activities with long-term value for both parties. The primary sources of risk include (9):

1. *Choice of local partner*
2. *Legal mode governing partnership*
3. *Adequacy and cost of financing*
4. *Appropriate frequency allocation*
5. *Permits, licenses, and other laws*
6. *Resolution of legal conflicts.*

The key to planning is to identify the sources of risk which are likely to occur, then to determine whether they will have a critical effect on the viability of a specific project (such as the AMPS-based HCMC mobile telephone joint venture). One useful technique for this type of strategic planning is called scenario analysis.

4. SCENARIOS FOR POLICY ANALYSIS

Derived from the confluence of game theory and computer simulation (10), scenario planning is a useful technique for exploring interactions between current choices and the future environments in which those choices will have consequences. The technique generates a set of likely contexts in which plans can be developed and evaluated. The modern scenario dates to the Manhattan project, which used simulation techniques to estimate the chance that the first nuclear explosion might extinguish all life on our planet (11). The Rand Corporation later developed scenario planning for Pentagon use. SRI International adapted the technique to corporate planning in the 1970s (12). Current users include Royal Dutch Shell and other transnational firms operating in turbulent contexts.

Forecasting is inappropriate when the future is likely to be affected by trends that are not simply extrapolations of the present, and events for which there is no historical precedent (13). In dynamic contexts, forecasting is useless for longitudinal analysis. A scenario is "A hypothetical sequence of events constructed for the purpose of focusing attention on causal processes and decision points (14)." It normally consists of a logically coherent description of fundamentally different futures, which ideally explains the dynamic interactions between key elements from the present to the end point of the scenario. By forcing consideration of alternative futures, scenario planning allows policy makers to make explicit their assumptions about the future. Used to identify major opportunities, threats, and uncertainties, the technique facilitates learning at low real and opportunity costs.

4.1 STAKEHOLDER INVOLVEMENT

The first step is to identify those whose interests may be affected either by the plan or by its consequences. Direct stakeholders normally include top management, key functional managers, customers, and owners, stockholders, or other sponsors. In network-based industries (such as telecoms and transport), suppliers, labour leaders, public officials, and indirectly, even competitors are stakeholders in the structure of the industry.

The next step is to involve the stakeholders in the planning process. Ideally, such involvement adds more value to the planning process than cost. It also can pave the path toward adoption of the resulting plan. One way of achieving this is to ask stakeholders to forecast the future environment. Delphi and cross-impact techniques (15) attempt to structure and formalise judgmental forecasting. When used for cross-sectional analysis, they help sort those key variables for which forecasts vary around a central tendency from those for which forecasts diverge. Because continuing divergence reveals different assumptions regarding structure in the future, it is the ideal base for scenario building.

4.2 BUILDING MULTIPLE SCENARIOS

Drafting a scenario requires special knowledge and skills, plus cooperation between functional specialists and external experts. The central and most important step is to identify the key decisions which are sensitive to environmental factors. Participants then postulate future values (and states) for these factors, which are then used to test the viability of alternative strategies. As noted above, Delphi techniques are an efficient way to identify these critical scenario dimensions, and to differentiate structural and parametric variables.

From potential decisions, the analysis path leads outward to task-related decision factors (*e.g., internal economic forces, constraints to technology trade, demography, political developments, etc.*) that may affect the outcome of each decision. The next level contains remote forces (*e.g., the world economy, changes in values and lifestyles, trade blocs, etc.*) that may determine the future values and states of these forces and key decision factors. The many permutations of interactions between these values are reduced to a few contrasting, yet plausible sets (16). These "scenario logics" facilitate tests of the robustness of alternate strategies under different assumptions about the future. They focus on the interplay between environmental forces and decision factors (17). Thus, a useful scenario must represent those dimensions of an alternative future which are critical to the decisions actually at hand.

Usually, two to four scenario logics are enough to highlight critical variables in the task environment. For a wireless operator considering a major new investment, key variables might include national standards for telecommunications technology, laws and regulations governing investments, and links with potential joint venture partners. Factors in its remote environment include growth in personal incomes, national and regional policy governing market access, new technologies, nationwide frequency allocations, factors influencing user perceptions of service value, and performance, cost, and access to regional, national, and global telecommunications infrastructure. Three dimensions, each with only two states, might economically represent the critical institutional scenario dimensions for the operator. As some factors overlap, the draft set of scenarios might include only the following four:

TABLE 6: FOUR SCENARIOS FOR 21ST CENTURY TELECOMMUNICATIONS POLICY IN VIETNAM:

SCENARIO/ **Dimension:**	**Munificence**	**Stability**	**Harmony**
1. ASEAN, Inc:	**M+**	**S+**	**H+**
2. CITIES FIRST:	**M+**	**S+**	**H -**
3. ZERO-SUM:	**M -**	**S+**	**H -**
4. TROUBLED WATERS:	**M -**	**S -**	**H -**

LEGEND:

M **Munificence**: resource availability vs. scarcity (*CAPITAL, SKILLS, TECHNOLOGY, SPECTRUM*)

S **Stability**: absence of intense internal or regional political or economic conflict, and

H **Harmony**: e.g., the balance between rural and urban access and tariff policies and service needs.

These capture interaction among key structural variables: in the example above, the normatively healthy "ASEAN, Inc" scenario describes an open policy regime in which stable yet balanced internal and external relationships drive economic and social development, in stark contrast to "Troubled Waters." A "Cities First" scenario describes a situation where rural interests are unable to capture needed resources, while the "Zero-Sum" scenario portrays intense competion for scarce resources (which describes the present context, but may not accurately represent the future). Once fully developed, these provide alternative contexts for evaluating competing plans. Another technique works back from critical variables (such as future GDP per capita) toward scenario logics. For any technique, the final set of scenarios should be (18):

1. *Concerned with relatively long time frames,*
2. *Focused on a set of related choices,*
3. *Limited to environmental trends and events,*
4. *Representative of the full range of uncertainty,*
5. *Attuned to the current environment.*

Concerned with relatively long time frames: It may take five to ten years to put in place major new backbone telecommunications network or wireless architecture for large organisations. The normal payback period for such an investment ranges from one to several decades.

Focused on a set of related choices: Planners should focus scenario planning exercises on choices with strong interaction effects. The task environments supporting telecommunications marketing activities are dissimilar to those which support network maintenance. As interaction between these systems is low, the key dimensions of the relevant scenarios are likely to be different. Unless integration of these two activities is a strategic option, they are best treated separately.

Limited to environmental trends and events: A scenario should focus on dynamic interactions among external forces which influence operations. One key design goal is to reveal interactions which may lead to novel or uncertain outcomes. In the 1980s, interactions between Tokyo's high traffic density and the character-based Japanese written language led to investment in the development of the modern facsimile machine, its rapid adoption in that country, and the subsequent domination of the world market by Japanese firms. Similarly, rapidly improving data compression capabilities may interact with increased miniaturisation to replace the home telephone number with a radio-linked personal access number for all individuals. If this occurs, emergent demand for related new products and services will influence the operations of some organisations far more than others.

Representative of the full range of uncertainty: Some events, like a new government, corporate merger, or emergent technology, are essentially multivalent. Other outcomes, varying like the tide around a central tendency, are candidates for sensitivity analysis. A plan which must succeed must be viewed in the full range of future contexts, not only those which seem most likely. Planners must draft scenarios to reveal the consequences of current choices in alternative future environments.

Attuned to the current environment: A scenario is only the canvas for more elaborate treatment and analysis to find the critical opportunities, threats, and issues in each scenario, and to identify those policies which will be the most robust in the more likely outcomes. With such an understanding, the focus of analysis can shift to the consequences of present choices. Analysis is largely qualitative until this final stage of the scenario planning process.

5. FROM STRATEGY TO IMPLEMENTATION

Once the scenarios are complete, the focus shifts to task-level decision factors that may affect the outcome of key decisions. At each step, multiple scenarios serve to highlight specific needs for domain knowledge, define the boundaries for analysis, and differentiate the critical variables. For a wireless project, the steps might include:

1. *Design and propose politically and financially viable projects based on transferring modern technology in a legal structure to suit regulators.*
2. *Select a partner with strong political and organizational assets, and steer the relationship toward joint benefit.*
3. *Package both technical training and management development with all technology proposals.*
4. *Design systems and plan growth to overcome inherent infrastructure restrictions (e.g., electrical power, tower space, underground cable).*
5. *Seek advisory and liaison services from a strong local consultant prior to preparing and submitting proposals to potential partners or the government.*
6. *Structure relationships (to the extent possible)for the long term, even if many key contractual commitments or policy issues are uncertain at the early stages.*

A policymaker can acquire an understanding of the challenges facing investors by examining each step in the light of contrasting scenarios. Similarly, potential investors can highlight issues which may become more critical under some scenarios than others. For example, if urban interests capture scarce resources in a Cities First scenario, rural interests must find incentives to attract investors, and access to network infrastructure becomes strategic. And under either ASEAN Inc or Cities First scenarios, even investors who have operated for several years without formal licenses may find they lose the ability to expand their market scope.

6. CONCLUSIONS

Vietnam must address four main challenges in building up its national information infrastructure to compare with other ASEAN members: raising sufficient capital, integrating the diverse equipment types currently in use, reforming its excessively complex and inefficient administrative processes, and developing technical and management skills (19). With plans to spend nearly US$3 billion over the next five years, Vietnam faces stiff rivalry for capital from other expanding Asian economies, which will seek ten times this amount over the next decade for telecommunications alone, and even more to fill rising needs for transport, energy, sanitation, and water treatment facilities (20).

In a fully evolved market, demand will far exceed current capacity, and system integration will thus become a critical success factor (21). Ten years ago, the national network was fashioned from obsolete Soviet and French gear. The current inventory of digital switching equipment, largely obtained through aid, is new but incompatible (22).

Officials claim telecoms deregulation is underway, whlie foreign investors see a lack of mechanisms such as a telecoms act as a critical gap (23). In fact, the most critical issue is not the lack of laws, but of monitoring and enforcement capacity.

Manpower to maintain the new national network is critical for long-term development. This may be a difficult task within the Vietnamese academic tradition, which provides advanced training to a small number of students through close supervision by a senior faculty member (24). With 3,000 IT professionals today, Vietnam hopes to add 20,000 by the end of this decade (25). According to some observers, even this may not be enough.

By using scenario analysis to identify such critical bottlenecks, then taking action to overcome them, policymakers in Vietnam can smooth the path for telecommunications investments. Investors can also benefit from scenario analysis. Investment always entails a certain degree of risk, particularly in a poorly structured situation such as the wireless market in a developing country with an emergent commercial legal system. Using this technique, preventive decisions and actions can be identified, which if executed with care, will mitigate many of the significant barriers to success the emerging market for wireless services in Vietnam.

Wireless technology can facilitate Vietnam's leap from its obsolete and inadequate network to a fully modern digital infrastructure which provides high-quality basic services to every village, and state-of-the-art services to business subscribers in its cities. While use of the scenario technique can illuminate many of the barriers to this innovative leapfrog approach to development, the government must still formulate and implement the measures necessary to overcome these barriers to success.

SELECTED REFERENCES

LEGAL WRITINGS

Council of Ministers, Decree 18 HDBT, Detailed Provisions for Implementation of the Law on Foreign Investment in Vietnam, Hanoi, 16 April 1993.

Council of Ministers, Decree 49-HDBT, Detailed Provisions for Implementation of the Ordinance on the Transfer of Foreign Technology into Vietnam, 4 March 1991.

MOSTE 28/TT-QLKH, Circular on Transfer of Foreign Technology to Vietnam, Hanoi, 22 January 1994.

Pham Khac Chi, "Vietnam Development Policy and Procedures on Investment," Foreign Investment Service Company, HCMC, 1994.

INDUSTRY INFORMATION

MOSTE, I.T. 2000 Programme (Vol. I), Hanoi, 1994.

Nguyen Ngo Hong, National Network Development and the Role for Foreign Investment, Ministry of Post & Telecommunications, Hanoi, 1994.

Tamura, et al; Terminal Report on National Telephone Network Expansion Plan in Vietnam," Asia-Pacific Telecommunity, Bangkok, July 1994.

Telestra, Telecommunications Network Development Plan (Vol 1), Ho Chi Minh City Posts & Telecommunications, 20 September 1993.

SCENARIO PLANNING

Davis, N; Lawrence and Oppenhiemer, Simon and Schuster, New York, 1968.

Huss and Honton, "Scenario Planning - what style should you use?" Long Range Planning, Vol 20 #4, 1987; pp. 21-29.

Kahn, H, and Weiner; The Year 2000, Macmillan, London, 1967, p. 6.

Kahn, H; The Future of the Corporation, Mason and Libscomb, New York NY, 1974.

Mandel, T; "Scenarios and Corporate Strategy: planning in uncertain times," SRI International, Menlo Park, 1982.

Schnaars, S P; "How to Develop and Use Scenarios," Long Range Planning, Vol 20, 1987, pp. 105-114.

Schoemaker, P; "Multiple Scenario Development:: its conceptual and behavioural foundation," Strategic Management Journal, Vol 14 #3, 1993, pp. 193-213.

NOTES TO THE TEXT:

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1 CIA factbook 1994, World Wide Web, 10/15/1995.

2 Le Dieu Anh, Working paper, Institute for Economic Research, HCMC Peoples Committee, 1995.

3 Pyramid Research, "Telecoms Markets in Vietnam, Laos, and Cambodia," Cambridge, 1995. p. 79.

4 Field interviews with industry officials January 1995.

5 Pyramid Research, 1995, p. 66.

6 Discussions with C-DOT officials, April 1991.

7 Pyramid, op. cit.

8 Telestra, Telecommunications Network Development Plan (Vol 1), Ho Chi Minh City Posts & Telecommunications, 20 September 1993.

9 Interviews with foreign operators and local industry officials, Hanoi and HCMC, 1995.

10 Schoemaker, P, "Multiple Scenario Development: its conceptual and behavioural foundation," Strategic Management Journal, Vol 14 #3, 1993, pp. 193-213.

11 Davis, N; Lawrence and Oppenhiemer, Simon and Schuster, New York, 1968.

12 Mandel, T; "Scenarios and Corporate Strategy: planning in uncertain times," SRI, Menlo Park, 1982.

13 Kahn, H; The Future of the Corporation, Mason and Libscomb, New York NY, 1974.

14 Kahn, H, and Weiner; The Year 2000, Macmillan, London, 1967, p. 6.

15 Helmer 1981, op cit., pp. 341-345.

16 Schnaars, S P; "How to Develop and Use Scenarios," Long Range Planning, Vol 20, 1987, pp. 105-114.

17 Huss and Honton, "Scenario Planning - what style should you use?" Long Range Planning, Vol 20 #4, 1987; pp. 21-29.

18 Schnaars 1987, pp. 105-114.

19 Chotrani, R; "Vietnam's Telecoms Challenge," Vietnam Business News, pilot issue, September 1995, p. 8.

20 Infrastructure, "How to Find $1.5 Trillion," Asiaweek, September 29, 1995, p. 58.

21 Telestra, Telecommunications Network Development Plan (Vol 1), Ho Chi Minh City Posts & Telecommunications, 20 September 1993.

22 Gilbert, L; "A Framework for Building National Information Infrastructure: the evolution of increased reach and range for prosperity in Singapore," in press 1996.

23 Chotrani 1995, loc. cit.

24 Interviews, Hanoi Technological University, January 1995.

25 Chotrani, R; "Vietnam's IT Revolution, Vietnam Business News, pilot issue, September 1995, p. 16.

THE IMPACT OF LOCAL COMPETITION ON UNIVERSAL SERVICE POLICIES

Robert K. Yates, BASc, M. Eng., MBA
Johanne Lemay, P. Eng., MBA

LEMAY-YATES ASSOCIATES INC.
2075 University Street, Suite 1000, Montreal, Quebec H3A 2L1 CANADA
Tel: (514) 288-6555 • Fax: (514) 288-6527 • E-mail: 73204.3352@compuserve.com

ABSTRACT

New technologies, combined with the imperatives of competition, privatization and deregulation are creating a telecom industry where competition is the norm in all segments. Competition in domestic markets began with terminal attachment, followed by information services and long distance. The "final frontier" is the local network.

The local network was long considered to be a natural monopoly, particularly when low-population density and remote areas were included. This century-old paradigm is being challenged by the emergence of alternative local networks. Alternative networks may be entirely new, or built on cable television or wireless infrastructures. This paper focuses on identifying infrastructures that can support universal service, on an analysis of universal service issues in an era of multiple local infrastructures, and provides a business case model for small local telephone and cable television service providers (based on the Canadian environment). The investment required for each to enter the other's business, and their comparative ability to do so is investigated.

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1. INFRASTRUCTURES TO SUPPORT UNIVERSAL SERVICE

Three possible infrastructures are considered as having potential to provide universal service: the telephone network, wireless networks and cable television systems.[1] Local competition implies that there could be multiple infrastructures.

Each of the telephone, wireless and cable infrastructures were developed for specific needs, using distinct technologies. In the context of basic plain old telephone service (POTS), the telephone network is the only one capable today of meeting a universal service objective. With expanding customer needs and rapidly changing technology, what is considered to be basic is changing. Networks other than the telephone network (or working in combination with it) may be more appropriate for a future universal service model.

1.1 TELEPHONE COMPANIES

To keep up with changing demand, and to support business evolution, the telephone companies (telcos) have continued to invest heavily in infrastructure. Recently this has meant evolving the networks to accommodate broadband services. Broadband networks are expected to provide new services such as Internet access and video dialtone. The investments are large and speculative, and have virtually no impact on basic phone service.

Capital spending on broadband is therefore only really for new services. This raises the question of whether reasonable costs can be maintained for the average telephone subscriber, since new services are speculative and revenue expectations may be too high.

1.2 WIRELESS NETWORKS

Cellular phone service is now considered as "basic" by many business users, particularly due to the mobility afforded by the service. The evolution of wireless, in particular "personal communications services" (PCS), is leading towards greater ubiquity and lower costs.

Although wireless services could not presently be counted on to provide universal service, (Since geographic coverage is normally much lower than population covered), they should be considered to be an integral part of a domestic communications infrastructure. Wireless technologies already play a role in the provision of basic service where topographic conditions do not lend themselves to the provision of cabled infrastructure."

There are a number of considerations for wireless technologies in the context of providing universal service:

- Cost - Even though costs have been declining, wireless is more expensive than POTS.
- Reliability - Public networks have not typically been designed with the same overall reliability objective that the land-line networks have. The weak link may ultimately be at the subscriber end, since a wireless network cannot power the subscriber's handset.
- Integration with POTS - Cellular has traditionally operated its network "in parallel" with POTS. Cellular has its own set of telephone numbers, uses different backbone facilities, has a separate invoicing system, etc. Full packaging with POTS (including number portability) would facilitate the wider use of wireless for basic service.

1.3 CABLE TELEVISION

Cable television is universally available in a number of countries. Cable companies (cablecos) are in the process of making large investments in infrastructure to keep up with technology changes and to ward off competition from direct-to-home satellite services and from the telcos.

There are many barriers to entry for cable companies considering entry into telecom markets, for example:

- Technologies to provide telephone service on coaxial cable are developing rapidly but are not yet mature. Terminal equipment for connecting home phones to the cable company drop wire is also currently quite expensive,
- Cable companies have typically had a relatively low investment per subscriber and have been able to stage their investments. In entering telecom businesses, however, the cablecos will face large initial investments in switches, fiber cables, etc., and,
- There are often regulatory barriers for cable companies to enter the public switched local services market. For example, cable companies would have to be able to assign local telephone numbers, which are currently controlled by the telcos. Removing regulatory and technical barriers to entry such as this is a long and complex process.

1.4 MULTIPLE INFRASTRUCTURES

There are many possibilities for development of alternative local infrastructures. There is not one particular infrastructure that can provide all services today. Telephone networks are suitable for POTS, but require upgrading for broadband and entertainment services. Cellular provides mobility and the potential for basic POTS, but is expensive and limited in its ability to address broadband and, entertainment services. Cable television is broadband, but requires major investments in order to offer telephone services.

2. UNIVERSAL SERVICE IN AN ERA OF LOCAL COMPETITION

Canada, for one, has been very successful in ensuring a broad penetration of basic telephone service in the traditional monopoly industry structure. The ITU shows Canada as having the highest penetration of residential telephone lines (about 37 per hundred population), ahead of the US, the UK, Australia (all three approximately 30 per hundred) and Japan (approximately 25 per hundred).[iii] The combination of existing universal service policies, and the consumers' desire for telephone service, has served Canada well.

With the introduction of long distance competition in 1992 (Telecom Decision CRTC 92-12), new entrants were built into the system of cross-subsidy. Interexchange carriers and resellers pay contribution to the telcos to offset the cost of local access. This contribution is intended to help ensure that the telcos continue to be able to provide universal service.

The contribution mechanism, and policies to support universal service, become more complex issues in an environment of local competition. If there is local competition, it is not clear which carriers should be eligible to receive contribution or how to deal with local-to-local contribution.

With expanding "basic" needs, there is also a risk of subsidizing too broad a package of services. Should new entrants receive contribution (on the same basis as the incumbent telcos) or pay contribution (to support local-to-local, and business-to-residential subsidies)?

A way around the complexity is to unbundle contribution and develop explicit subsidies. This would avoid the possibility of market distortion, and also ensure equability in the application of the mechanism.

There are three groups which can be considered as being the most in need of a universal service policy. These are (1) populations in remote areas, (2) low income households, and (3) the disabled[iv]. To address these, a universal service fund could be created to which all carriers (including the telcos) would contribute. Other explicit mechanisms could be also be developed such as tax breaks, some form of voucher for service, lower lifeline rates, etc.

The notion that incumbent telcos have local access costs that exceed revenues is common to many places. In the UK, the British Telecom (BT) accounts were divided into line rentals, local calls (i.e. account service revenue), national calls and international calls. The UK "access deficit" was based on costs for line rentals being below revenues.

Competition was introduced in the UK on an end-to-end basis, i.e. there was no distinction made between local and long distance carriers. The same dilemma as illustrated above, however, existed due to BT's "access deficit" to which new entrants would be required to contribute. Oftel (the British regulator), however, was authorized to waive payments for new competitive domestic traffic until 15% market share is reached[v]. Once the competitors do reach 15%, the "problem" will come back.

The value of the contribution waivers (as of mid-1995) was about £150 million. The waivers remain in effect until March 1996.

3. BUSINESS CASE STUDY OF SMALL LOCAL SERVICE PROVIDERS

Major telephone and cable companies have announced large infrastructure investments to support the evolution of consumer demand. This creates pressure on smaller service providers to consider making the same investments. This section explores:

- The financial profile of small service providers, based on a hypothetical example community of 2,000 households called Smallville.
- The cost of developments in infrastructure to support the information highway in Smallville.
- The potential for economies of scope in Smallville if the telephone and cable companies combine their investments.

3.1 SMALLVILLE TELEPHONE AND SMALLVILLE CABLE

Smallville is assumed to be presently wired for telephone and cable services. Based on typical Canadian service penetration, Smallville would presently have 2,513 telephone lines (including residential and business) and 1,594 cable subscribers.

Basic residential phone service in Smallville would cost $8.44 per month and business $24.36 (both including touch tone). Consistent with small communities, there is a relatively high proportion of residential lines. The weighted average tariff per line per month is $11.63.

The total revenue per month per line for Smallville Telephone would be $38.46 when pay telephones, optional local services and access charges for long distance are included.[vi]

Basic cable television service costs $20.77 per month based on rates in typical small Canadian cities. Smallville Cable is assumed to offer extended basic and pay television, but not pay per view. The total revenues per month, based on typical penetration rates, would be $25.41 per subscriber for 1,594 subscribers.

The pro forma income statements based on the above assumptions are shown below (derived from Annual Reports and other sources):

Smallville Telephone

		% of sales		Amount
Gross Revenues				
- basic		33%	$	381,981
- access to long distance		67%	$	777,898
Total gross revenues		100%	$	1,159,879
Expenses		59%	$	679,778
Operating Profit			$	480,100
		Operating margin		41%
Depreciation		23%	$	266,488
EBIT			$	213,612
		Profit margin		18.4%
Avg net fixed assets per line	$	1,619		
				RNFA
Avg net fixed assets	$	4,068,404		5.3%

Smallville Cable

		% of sales		Amount
Total gross revenues		100%	$	485,959
Expenses		56%	$	273,407
Operating Profit			$	212,551
		Operating margin		44%
Depreciation		22%	$	105,621
EBIT			$	106,930
		Profit margin		22.0%
Avg net fixed assets				
per wired household	$	229		
per subscriber	$	287		RNFA
Avg net fixed assets	$	458,206		23.3%

Several observations can be made:

- The Telephone Company is much larger (over 4 times in revenue). This is due to its ability to address business customers as well as residential, and to the revenues received for providing access facilities for long distance calls.
- The Cable Television Company is more profitable (on a % basis).
- The Cable Television Company has much lower net fixed assets (11% of the telco), and is therefore much more profitable when return on net fixed assets (RFNA) is calculated (23% versus 5% for the telco).[viii]

3.2 COST OF INFRASTRUCTURE FOR THE INFORMATION HIGHWAY

The information highway opens up new sources of revenue for both the telco and the cableco. Under a simple scenario Smallville Telephone may choose to invest in the cable television and interactive services markets and Smallville Cable may choose to invest in the telephone and interactive services markets.

A summary of the investments required is shown below for the case where each gains 15% share of the other's basic market. Investment costs are based on generalized information from vendors and other sources[viii]. To keep the costs at a reasonable absolute level, a number of investments have been estimated as allocated costs. For example, if the cable company upgrades its coax plant to provide telephone and interactive services, the upgraded plant would also provide capabilities to support the basic cable business. Costs are arbitrarily allocated on the basis of 50% cable/telephone.

Smallville Telephone		Investments required for telco to offer CATV services	
Video head-end	$	300,000	
Fiber feeder (allocated)	$	141,000	
Coax plant	$	962,000	
Total start up	$	1,403,000	
Cost per home passed	$	702	
Per subscriber cost			
Video server and switch	$	300	per sub
Penetration of CATV		15%	
Subscribers		300	
Added costs	$	90,000	
Total	$	1,493,000	
Cost per subscriber	$	4,977	
Cost per household	$	747	

Smallville Cable		Investments required for cableco to offer POTS services	
Fiber feeder (allocated)	$	141,000	
Coax upgrade (allocated)	$	354,000	
POTS switch (allocated)	$	625,000	
Total start up	$	1,120,000	
Cost per home passed	$	560	
Per subscriber costs			
Subscriber interface	$	350	per sub
Switch line additions	$	200	per sub
Pentration of POTS		15%	
Subscribers		300	
Added costs	$	165,000	
Total	$	1,285,000	
Cost per subscriber	$	4,283	
Cost per household	$	643	

The level of investment per subscriber for both the telco and the cable company is very high. Under the optimistic cost allocation model shown above, the telco investment would be $1.49 million and the cableco investment of $1.28 million.

If the cableco cannot share its POTS switching costs, its investment would increase to almost $2 million. The cableco is also depending on sharing its coax and fiber investments with basic cable service. If basic cable service does not need these investments, the total attributable to telecom would rise to $2.4 million, 60% more than the telco's investment.

The relative size of the investment is much larger for the cable company. Smallville Cable currently only has $458,200 in net fixed assets and needs to invest $1.28 million or more to enter the telephone business. This would increase its assets by almost 300%.

On the other hand, Smallville Telephone already has $4 million in net fixed assets. Its investment to enter the cable business would increase this total by only 37%. The telephone company is clearly in a better position to finance its expansions into the cable company's business, even though the absolute value of the investment is higher, and the economies of scope are lower.

It is important also to consider that the technologies are all relatively immature, (making any cost estimate somewhat speculative).

3.3 POTENTIAL FOR ECONOMIES OF SCOPE IN COMBINED INFRASTRUCTURE

The potential for economies of scope in combined infrastructure can be analyzed by assuming that the telco uses the existing cableco infrastructure or the cableco uses the existing telco infrastructure.

If the telco uses the coax cable and the head-end of Smallville Cable, its investment costs would be reduced by 60%. If the cable company uses the telco switch, its costs would be reduced by 49%. Thus, based on this simple capital investment scenario, there are benefits in combining infrastructures in order to increase the possibility of having a project with positive value.

On the other hand, the two companies would be competing with each other and any lease or sale of facilities to the other party would result in lower revenues for the lessor/seller. On an opportunity cost basis, therefore, both parties would do calculations to arrive at the equivalent worth of the facilities, and attempt to charge the other party accordingly.

All else being equal, the value (on an opportunity cost basis) of sharing the facilities can be assumed to be equivalent to having to build them, and therefore the resultant value of the project would not change. If the telco and cableco decide to cooperate, there could be cost benefits in combining infrastructures (although this should be considered as collusion and anti-competitive).

The information highway business case will be difficult for both small telcos and cablecos. The telcos' potential advantage is that the incremental investment is lower (relative to the size of their existing assets) even though in absolute terms it is higher.

The cablecos' potential advantage is in being able to make use their existing infrastructure to support both cable and telecom services, as well as new interactive services. Even though it may be more difficult to finance, the cablecos have greater potential for economies of scope with their existing business.

4. CONCLUSIONS

- Universal service policies should be designed to account for multiple infrastructures which will be able to support basic service. Any network operator capable of meeting universal service obligations should be eligible to receive subsidies, if they exist.

- To avoid market distortion, any universal service subsidy should be explicit and unbundled. Local competition should develop where it is viable, and not where subsidies make it appear to be viable.

- Government policies and regulations should not pre-judge where and how local competition will develop. New solutions could stimulate competition in smaller areas where "traditional" drivers are less present.

- Many new services can be offered by entrepreneurs. Safeguards may be required to ensure that the telco is not able to offer itself a "better deal" than others would get.

- In larger centers, there will likely be at least one competing information highway in parallel with the telco information highway.. The unbundling of the telco network, including addressing how contribution will be dealt with in light of local competition, is a critical issue in (1) ensuring that competition will be viable, (2) in creating opportunities for innovation in networks and services, and (3) ensuring that there is a level playing field for the evaluation of investment opportunities by potential investors in new infrastructure.

In countries where telephone penetration is currently low and cable television is still emergent, the above principles are even more critical. Since telecom, wireless and cable television infrastructures, hold out the potential of providing universal/basic services, a policy environment that stimulates choice and competition should be put in place as networks are built".

THE AUTHORS

Robert K. Yates is co-founder of LEMAY-YATES ASSOCIATES INC. a management consulting firm whose mission is to create new opportunities for telecommunications services and products. LEMAY-YATES ASSOCIATES consults to key players in competitive access, multimedia, cable television, telecom services and telecom equipment manufacturing. LEMAY-YATES ASSOCIATES is well recognized as a leader in the area of technological convergence.

Mr. Yates holds a Masters degree in Engineering from the University of Toronto and an Executive MBA from Concordia University of Montreal. He has worked as a consultant to the cable television and telecommunications industries for the last 7 years. He also worked for 10 years with Bell Canada and Northern Telecom, in the areas of new technology development, marketing strategy and market management.

Ms. Johanne Lemay is co-founder of LEMAY-YATES ASSOCIATES INC. She has been active in high technology and in the telecommunications and cable distribution arenas since 1980. She has been consulting to industry and governments for the last 5 years and has participated in policy and regulatory activities related to both telecommunications and cable television. She began her career at Bell Northern Research and Northern Telecom where she was responsible for product line management and for international marketing for the Pacific Rim and Latin America. Ms. Lemay graduated from Laval University in Quebec City with a Bachelor's degree in Applied Science (Engineering Physics) and from Concordia University in Montreal with an Executive MBA.

Ms. Lemay and Mr. Yates are co-authors of the papers: *"Exploiting Technological Convergence to Stimulate Telecommunications Infrastructure Development"*, presented at PTC'94 and *"An investigation of Technology Convergence as an Enabler in the Local Loop"*, presented at PTC'95. They are also co-authors of a 350-page Market Report entitled *"Local Telecom Competition in Canada"* published by LEMAY-YATES ASSOCIATES INC. in June 1994.

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[1] There are other possible infrastructures. For example, power companies have ubiquitous access to residences and businesses. Also, satellites cover most regions, but often earth station cost is prohibitive for "conventional" telephone service. These should be considered a possible longer-term infrastructures for basic local service. A discussion of alternative domestic infrastructures is found in "Exploiting Technological Convergence to Stimulate Telecommunications Infrastructure Development", Robert K. Yates & Johanne Lemay, proceedings of PTC'94, pp. 209-225.

SR Telecom, for one, is a provider of fixed point-to-multipoint microwave systems that support basic telephone service. Its systems have been deployed to serve mountainous or isolated areas and island nations. There are also satellite based wireless telephone projects. Iridium (led by Motorola) and others are expected to develop lower cost satellite phone technologies providing world-wide "cellular" service. These projects could have a positive impact on availability of service, particularly in remote areas.

The Changing Role of Government in an Era of Telecom Deregulation, "Briefing Report No. 2: Universal Service and Innovation: Fostering Linked Goals through Regulatory Policy", International Telecommunication Union, Geneva, February 1994, page 40.

See for example Attachment A to paper by Andrew Lipman, "A Paradigm for Universal Service in a Pluralistic and Competitive Telecommunications Environment", Proceedings of PTC'95, page 158. These considerations are also echoed in The Changing Role of Governments in an Era of Telecom Deregulation, Interconnection: Regulatory Issues, Report of the Fourth Regulatory Colloquium held at ITU Headquarters, 19-21 April 1995, page 60.

Telecommunications Reports International - July 22, 1994 v5, i15.

Revenue from providing access to long distance was estimated by using rates from the Ontario Telephone Association (OTA). The OTA is the association of non-Bell Canada telcos in Ontario.

Note: Figures were derived using Canadian statistics. It should be noted that many small Canadian cable companies lease part of their facilities from the telcos (coax cable, poles). This has not been accounted for in the comparison.

See for example "Cable Television Competition in Canada", submitted by the Canadian Cable Television Association as Evidence in the Proceedings pursuant to Public Notice CRTC 94-130. The Evidence includes an appendix on network infrastructure costs and potential revenues developed by LEMAY-YATES ASSOCIATES INC., January 1995.

For example, this has been the approach in the Philippines. See "Telephone and Cable Television Convergence in the Philippines - Policy Perspectives from a Developing Country", A.A. Rubio and Victor A. Banning, Proceedings of PTC'95, January 1995, page 13.

Telecommunications in Transition: A Canadian Perspective on Ownership and Other Key Issues

Meriel V.M. Bradford
Teleglobe Canada Inc.
Montreal, Canada

1. ABSTRACT

As the trend to privatization and deregulation in global telecommunications gathers momentum, considerations such as ownership, interconnection and equivalent market access have become an issue for carriers and governments throughout the Pacific. This paper will make the case that new ground rules intended to resolve potentially thorny issues such as equivalent market access cannot be based solely on the US experience. There are other valid models that must be taken into account. Furthermore, everyone's long-term interests will be best served by eschewing the traditional bilateral approach in favour of more broadly-based regional and multilateral telecom arrangements, through the likes of the World Trade Organization (WTO), the North American Free Trade Agreement (NAFTA) and APEC (the proposed Asia-Pacific free-trade area).

2. BACKGROUND

It is said that the Chinese have a sophisticated understanding of the turmoil which frequently accompanies abrupt change: In their written character symbol for "crisis", they combine the images of "danger" and "hidden opportunity"—expressing a philosophy that change, though perilous at times, also holds the promise of new opportunities.

It would be somewhat of an overstatement to imply that the telecommunications industry is in serious crisis. However, with globalization, our industry is undergoing sweeping changes—changes that have compelled us to rethink many of the basic precepts regarding ownership, traffic handling, rate-setting and revenue-sharing that have long governed the way we do things. So we might do well to heed the wisdom of our Chinese friends and bear in mind that the demise of the old telecom world order—unsettling as it might be in some regards—also provides the opportunity to devise a new framework more appropriate to the times.

The problem, as I see it, is essentially one of transition. Some players are at different stages than others in this transition to a new world order. And some regions are at different stages than others.

The process of market liberalization is well advanced in countries such as the United States, the United Kingdom and Canada, where Teleglobe has recently helped expedite the process by proposing that the facilities-based intercontinental market be opened to competition.

The trend to liberalization in these national markets has helped provide an impetus for broader regional telecom agreements under the auspices of NAFTA and the European Union. And the major carriers from these regions—AT&T, Sprint, MCI, BT, France Telecom and Deutsche Bundespost among them—have moved swiftly to form global alliances that will enable them to exploit opportunities arising from a new, more-competitive regime.

Change is evident elsewhere as well. For instance, quite a number of nations in the Asia-Pacific—Australia, Indonesia, Japan, Malaysia, New Zealand, the Philippines and Thailand, to name just a few—now allow foreigners to hold at least a minority interest in their telecommunications carriers. And several leading Asian carriers, KDD of Japan and Singapore Tel, have hooked up with AT&T in the World Partners alliance.

Regions where the trend to liberalization generally is not so advanced include Africa, Latin America and the emerging economies of Asia—although

107

foreign carriers are attracted by the prospect of at least a partial liberalization of the huge and potentially lucrative Chinese market, already a favourite of telecom equipment manufacturers from the industrialized nations.

Just as there are different stages of transition, so there are different views of precisely what form the transition should take: For instance, many jurisdictions favour allowing competition in cellular and value-added services but not in basic telephone service. Others advocate completely deregulated, wide-open markets. Still others would demarcate things by maintaining ownership restrictions on infrastructure while encouraging competition at the service-provider level.

Given the fact that telecom liberalization gained its first real foothold in the domestic US market, the experience here certainly is pertinent to any comprehensive discussion of telecom competition policy. However, I hope I won't offend our hosts at PTC when I characterize as somewhat parochial the typical American's view of telecom liberalization: To wit, their particular concept of open markets is clearly the best. Hence, everyone else in the world should emulate the US approach!

At any rate, these wide-ranging—often diametrically opposed—points of view must be reconciled, or at least taken into consideration, in any regional or multilateral approach to telecom liberalization.

There is no denying the growing interdependency between trade and telecommunications. Both the North American Free Trade Agreement and the General Agreement on Trade in Services (GATS) include detailed rules on telecommunications services. For the moment, it's mostly value-added services—i.e. electronic mail, voice mail, on-line information and data-base retrieval, and electronic data interchange (EDI)—that are bound by these trade pacts. However, that will soon change.

The European Union, for instance, is progressing with its vision of a single intra-European telecom market, beginning in January, 1998. There is some scepticism as to whether or not EU members will be able to work out all the details within that time frame. Nevertheless they are firmly committed to the idea of a unified regional market. Similarly, NAFTA is working out what to do in a semi-integrated North American market that Canada hopes will eventually encompass Chile and, doubtless, other parts of the Americas as well.

Last, but certainly not least in terms of potential importance, APEC members have agreed to work toward formation of a comprehensive, new free trade area by the year 2020 that would dwarf NAFTA in size. Both Canada and the US are players in APEC, and will participate in this market liberalization.

Needless to say, it will be quite a challenge for APEC to manage the changes in telecommunications in a manner that will keep it "in sync." with other regions and with the broader, multilateral WTO forum as that evolves.

The World Trade Organization's Negotiating Group on Basic Telecom or "NGBT"—which now includes more than 45 participants—is busy working to extend GATS to basic telecom services. This group is scheduled to complete its negotiations in April of 1996.

The new reality confronting us is this: Telecommunications policy can no longer be the sole preserve of national regulators such as the Canadian Radio-television and Telecommunications Commission (CRTC) or the US Federal Communications Commission (FCC). Domestic economic policy makers and regulators—whatever side of the Pacific they may be situated on—are being left with fewer policy options than ever before.

3. THE US STANCE

Nevertheless, in the midst of all these negotiations, you have the key player—the United States—going ahead and engaging in its own rule-making exercise regarding foreign participation in the US market for international telecommunications.

In February 1995, the FCC served notice of a proposal to subject foreign-affiliated carriers wishing to operate in the US market to a new market-access equivalency test. Under the proposed test, the FCC would determine whether "effective market access (including access for investment) exists or will exist in the near future" for US carriers in facilities-based international services in the primary markets of the foreign carrier.

The FCC has wisely chosen not to follow the path of protectionism, and to a great degree decided against adopting this approach. Instead, the FCC will require a demonstration of effective competitive opportunities where a foreign-affiliated applicant seeks to provide service to a destination country in which it controls a carrier possessing market power. If it cannot demonstrate such opportunities—and at this writing we have yet to see how this will play out in practice— hen it would be barred from serving that route on either a resale or facilities basis. It would not, however, affect opportunities to serve any non-affiliated route or a route on which the applicant is not affiliated with the dominant carrier. Thus the focus has shifted from preventing discrimination where there is the incentive and opportunity to do so, adopting punitive measures in reaction to policies in countries over which the applicant has no influence.

Major players in the US industry certainly seem to embrace a rather self-serving concept of what passes for market liberalization. Indeed, applications filed with the FCC this past August by our US entity, Teleglobe USA, seeking international resale authority have been strongly opposed by AT&T and MCI in a clear attempt to protect their home markets.

To my way of thinking, the sort of arbitrary reciprocity requirements advocated by these carriers in the US—particularly when applied on a narrow, market-segment basis—are inappropriate, given the range of conditions present among the various countries of the world. The FCC was correct in rejecting them in favour of a cleaner, destination-specific application. Marked differences in market structures and regulatory approach exist even between nations such as Canada and the United States, which have quite open regimes for telecommunications as well as very closely integrated trade and investment regimes under NAFTA.

There are many positive elements incorporated in the US model. But that does not mean that the US view of the telecom world, as articulated by AT&T, should be regarded as the perfect paradigm to be imposed lock, stock and barrel on the rest of us.

Application by the FCC of the proposed new market-access test could rightly be interpreted by foreign carriers and governments as a "closing" of the world's largest single telecom market, thereby undermining the progress that's been made on the telecommunications front through forums such as GATS, the EU and NAFTA. Furthermore, such action may violate the WTO's standstill provision by increasing leverage in negotiations.

In rejecting this overly protectionist view, the US has, in theory, opened its international markets to carriers of virtually any nationality, limiting opportunities only with respect to service to closed markets in which the applicant has a dominant foreign carrier affiliate. I would hope that in those cases in which the FCC must consider market openness abroad in ruling on an entry application, it would take into consideration the economic strength of the applicant relative to US carriers were they to enter the applicant carrier's home market, and the considerations which lead to the chosen industry structure. More importantly, I am eager to see the FCC convert its words into actions by swiftly granting applications filed by foreign- affiliated carriers which meet its stated criteria, and not succumb to the protests of incumbent carriers who wish to preserve their enviable market shares.

Moreover, in assessing competitive opportunities on affiliated routes, the FCC should apply its standard in a manner that would recognize to some extent the diversity of paths that various other countries are taking toward liberalization of their respective telecom markets.

The dangers of imposing a mirror reciprocity test remain even in the narrower context adopted by the FCC. The analysis which it proposes that the world adopt must not be so confined as to disregard the presence of mutually advantageous market opportunities in the respective markets and the full range of opportunities available to American companies in the foreign market.

4. THE CANADIAN MODEL

That leads me to the situation of Canada, and the unique Canadian telecom model, which has succeeded in providing users with first-class services at prices that are among the lowest in the world.

Despite its relatively small population—fewer than 30 million—and subsequent high infrastructure costs, Canada has more than 250 million kilometres of telephone and data networks, as well as a vast system of interconnected satellite, cellular and mobile radio networks. Its CANARIE (Canadian Network for the Advancement of Research, Industry and Education) and CANTAT 3 fibre-optic facilities combine to form the longest broadband network in the world!

Nearly 16 million access lines connect 99% of Canadian households to basic telephone service, which is provided by the nine regional operating companies that comprise the Stentor group. There are competing domestic long-distance and national cellular networks, and some 1,800 cable systems which make cable-TV and related services potentially available to 95% of Canadian homes.

The basic structure of the Canadian industry differs from that of the United States in several respects, most notably market segmentation. Regional telephone companies provide local services and—along with Unitel, fONOROLA and more than 100 resellers—handle long-distance traffic between Canada and the United States, which accounts for about 75% of all international traffic. Teleglobe, a private-sector enterprise, serves as the wholesaler of facilities-based overseas services, which are provided to end-users by resellers and by those same companies I just mentioned in relation to Canada-US traffic.

This is in marked contrast to the US where, despite over one decade of competition, AT&T continues to dominate the domestic and international long-distance markets, including overseas.

Not surprisingly, the competitive situation of the Canadian industry is affected to a considerable degree by our proximity to the United States—the world's largest single telecommunications market. Canadian businesses and consumers expect the same variety and quality of services that are available to their American counterparts, and at comparable prices. And because the Canadian and US long-distance networks have been closely integrated for years, "bypass" traffic routed to and, to a lesser extent, from Canada via the US—although in conflict with Canada's Telecommunications Act 1993—has become a fact of life. This practice persists despite Teleglobe's so-called "exclusive" mandate on infrastructure for overseas calls.

With these unique competitive pressures, the Canadian telecommunications market—in both theory and practice—is among the most open in the world to foreign participation. Since 1992, for instance, when facilities-based competition was introduced in domestic long-distance, US carriers such as AT&T and Sprint have taken substantial equity positions in Canadian long-distance service-providers. Unlike the situation in the United States, resellers and providers of international simple resale do not need a licence to enter the Canadian market, nor are they restricted in any way in terms of ownership.

My own company has responded to this pressure-cooker atmosphere by becoming more productive and by focusing resolutely on customer service and market needs.

A measure of our success in this regard was reflected in a 1995 headline in *The Economist*. The prestigious British magazine noted that Canada's international rates are among the lowest in the world. Indeed, Teleglobe has reduced Canadian overseas rates by almost 50% overall since the late 1980s, and we are working hard to continue this downward trend.

I've already alluded to the fact that Teleglobe is unique in providing only wholesale, facilities-based services. We do not offer any end-user or retail services. At home, as abroad, the domestic carriers handle marketing and end-user billing.

I should note, as well, that—in contrast to US practices—Teleglobe extends the concept of proportional return to resellers as well as facilities-based carriers.

It is against this backdrop that the Canadian government now finds itself wrestling with the issue of how to structure the framework for the Canadian international market, including the issue of Teleglobe's exclusive mandate to provide facilities for intercontinental services.

For its part, Teleglobe announced in November—to the surprise of many in the industry—that it will not seek renewal of this exclusive mandate, which is set to expire in April, 1997. In a submission to the Canadian government, Teleglobe instead proposed the establishment of a "sustainable competitive environment" for Canadian overseas telecommunications, which would entail opening the facilities-based intercontinental market to competition.

Teleglobe stressed that the need for a competitive policy framework is urgent and it outlined for the government the transitional terms and conditions under which competition should be introduced.

For instance, as a precondition to the licensing of Canadian entities affiliated with US carriers (for overseas facilities-based services in Canada), Teleglobe said Ottawa should ensure that Canadian service providers are afforded US market-entry opportunities "broadly equivalent" to those available to US companies in Canada. It urged the Canadian government to initiate negotiations with the United States to develop a bilateral regulatory agreement that would establish fair-market access and expedite the licensing of Canadian-affiliated service providers in the US market. And it contended that, until a rules-based integrated market is established (possibly through WTO negotiations), the current policy regarding bypass of Canadian facilities must be maintained and enforced.

Teleglobe also is cognizant of the need to take the next step and move to a liberalization and restructuring of the entire North American market for intercontinental telecom services. In this regard, it has asked the Canadian government to gain the necessary market access and binding rules, through the WTO. Another forum would be formal negotiations with the United States, Mexico and—eventually—Chile that would lead to a deepening of the telecom chapter of NAFTA to include basic international telecommunications services.

As well, we'd like to see a liberalization of the foreign-ownership rules which apply to Teleglobe specifically and to the Canadian industry in general. Currently, non-residents are prohibited from owning or controlling more than 20% of the voting shares of Teleglobe—a rule that applies to all Canadian carriers. And foreign telecom carriers are not permitted to hold any voting shares in Teleglobe. Foreign telcos may, however, invest in Canadian domestic carriers, subject to limits of 20% direct ownership and 33 1/3% indirect. At the time of writing, AT&T appears to be testing those limits by seeking to increase its stake in Unitel, as part of a corporate restructuring that has yet to be approved. Teleglobe's recent submission to Ottawa recommends that the foreign ownership ceiling, including that applied to foreign telecom carriers, be raised to 49%. This would maximize potential for the formation of foreign alliances and for infusions of capital from outside Canada, without relinquishing Canadian control.

These are some of the key questions we'd like to see addressed on the Canadian domestic front. We don't yet have all the answers. And there most assuredly will be widespread participation in this debate about what is the best approach for Canada to take regarding a new policy framework for telecommunications appropriate for the 21st century.

The outcome of this discourse should be of considerable interest to others in the Asia-Pacific sphere, who would benefit from acceptance of the view—however reluctantly by Washington—that there is more than one way to skin a cat, or to legitimately achieve liberalization in telecom.

5. A MULTILATERAL APPROACH

Although NAFTA and the WTO are understandably top-of-mind at the moment in terms of Canada's telecommunications trade initiatives, Canadians want to be full participants in the dialogue within the Asia-Pacific region. I'm a firm believer that the more we immerse ourselves in other, broader areas of growth, such as the Asia-Pacific, the better off we'll be— both as a country and, from Teleglobe's perspective, as a corporation. The more points of possible interconnection there are, the better it is for Teleglobe. For that matter, the entire international telecom industry as well as end-users stand to benefit from progressive, widespread liberalization.

So rather than pursuing myriad bilateral agreements on international value-added network services (IVANS), as AT&T is wont to do, why not devote our energies to extending such pacts to make them regional and multilateral in nature?

When we do sit down to negotiate regional or multilateral arrangements, the focus should be on areas that are really key in terms of making the much-ballyhooed global information highway a reality. I'm thinking now not just about ownership but also about interconnection and other aspects of liberalization, such as mutual recognition of licences, non-discriminatory accounting rates, as well as the establishment of competition rules that would be fair to and binding on all parties.

Obviously, there has to be some sort of regulatory oversight covering both pre-entry and post-entry market scenarios. But the rules must be transparent and equitable. Forbearance from regulation in competitive markets, too, should be an integral element of regional and multilateral telecom arrangements. We must avoid needless regulations.

What's more, we should not get too hung up on the facilities side of things when we talk about the need for telecom liberalization. Given the current trend toward a global infrastructure controlled by a relatively small number of players, it is in the provision of services that we may see the meaningful competition developing. Telecom trade pacts should reflect this eventuality as well.

At this point, I feel obliged to add a cautionary note by pointing to the potential for tension between the regional and multilateral approaches I've endorsed. And, for most countries of the Asia-Pacific region, a successful conclusion to the WTO telecom talks with as many signatories as possible endorsing the resulting agreement would represent an important step forward.

The WTO basic-services agreement must be truly multilateral in nature, must extend most-favoured-nation status to its signatories and contain specific provisions covering such key issues as investment, trade in services, and dispute resolution among others.

To sum up then, it has become increasingly clear that in the 21st century economy there will be only two real choices—increasing openness and liberalization, or increasing isolation. The question we all must face is how best to bring about a true liberalization of the telecommunications market.

I believe this goal can best be achieved by means of a multilateral approach to telecom policy-making—through regional groups such as NAFTA, APEC, the EU and, ultimately, on a global level through the WTO.

Having spent a considerable portion of my career as a trade negotiator, I'm well aware of the difficulties entailed in fashioning a consensus from so many varied and disparate views. Still, I'm confident that it can, indeed, be accomplished.

Bear in mind, however, that we are dealing here with a very fast-moving and fluid situation. Major developments are anticipated on several telecom-liberalization fronts in the weeks and months ahead.

PTC delegates should keep an eye on the progress of such pivotal proceedings as the WTO talks, the possible enhancement of NAFTA, APEC trade liberalization, the outcome of the FCC's deliberations on foreign participation in the US market and the debates in Congress regarding the pending US Telecommunications Act.

Stay tuned!

INTELSAT RESTRUCTURING: HOW CAN THE PUBLIC INTEREST BE SERVED?

GREGG DAFFNER
VICE PRESIDENT OF GOVERNMENT AFFAIRS
PANAMSAT
GREENWICH, CONNECTICUT - USA

ABSTRACT

INTELSAT is finally committed to a review of its mission and the development of options for its future restructuring. This process reflects its perceived need to reassess its ongoing identity in the face of the sea changes in technology, regulation and the structure of global telecommunications markets. The world now awaits INTELSAT's final analysis, to be conducted over the next year, before the recreated dominant international satellite system re-emerges in its new configuration. This paper describes INTELSAT's deliberations to date, evaluates its proposed solutions and concludes that INTELSAT is headed in the wrong direction which will further undermine the establishment of a competitive level playing field.

INTRODUCTION

The International Telecommunications Satellite Organization ("INTELSAT") was created in the 1960s as the realization of President John F. Kennedy's global communications vision. President Kennedy's goal was to establish the first globally ubiquitous telecommunications infrastructure to provide universal, international telecom service. On one level, this has been achieved. Today, INTELSAT successfully operates the world's largest satellite system with 25 in-orbit satellites, controlled by its 137 member nations, carrying in excess of 150,000 simultaneous public switched voice and data circuits to more than 170 nations and territories.

Beginning in the early 1970s, with the adoption of competitive entry policies for equipment providers, we have witnessed the erosion of the monopoly utility theory and the marketplace it fostered. By the late 1970s/early 1980s, competitive provision of long distance and international services had begun to be accepted and alternative domestic and international satellite systems were authorized. By the 1990s value-added and long distance and international service competition had become commonplace and even competitive local exchange services providers began operation. Developed and developing nations around the world first commercialized their state PTTs (establishing state-owned,independent operators) then privatized these PTTs (selling controlling equity shares to either the general public, foreign private operating companies or both) and authorized additional private competitive telecom service companies. Today over 60% of INTELSAT's "ownership" is held by private telecommunications companies.

The result for telecom generally--a diverse range of both telecom equipment and services at steadily decreasing prices. And with this policy/regulatory liberalization has come visions for national and global information infrastructure development (the NII/GII). Nonetheless, the INTELSAT

Treaty remains unaltered and the Organization has continued as the dominant international satellite institution operating under an intergovernmental treaty. Not surprisingly, over the past few years there has been an increasing call for the restructuring and privatization of INTELSAT, with even INTELSAT itself undertaking a concerted effort to study and perhaps transform itself in step with the fundamental metamorphosis of the industry.

In view of the profound developments in both the technologies and economic theories underlying the market for satellite services, the very existence of a global intergovernmental treaty satellite organization is a historical anachronism. Moreover, it is counterproductive and antithetical to the achievement of a genuinely universal GII. Treaty INTELSAT should be terminated and in its stead, should be created multiple privately-owned global satellite systems vigorously competing both with each other and with other satellite systems and terrestrial alternatives, in order to provide the widest range of diverse telecom services at the lowest cost to the broadest number of users. The alternatives of creating a corporate subsidiary or a single "private" operator will both lead to greater opportunities for anticompetitive behavior and are not in the public interest.

The continuing failure of PTTs and monopoly private operators alike to meet the communications requirements of the vast majority of the world's citizens means that most people have never even used a phone. Satellite-based services hold the promise of achieving ubiquitous and truly universal services, and INTELSAT holds the key to realizing this promise.

BACKGROUND

The birth of INTELSAT coincided with the advent of the cold war, at a time when state-owned monopoly telegraph and telephone operators were the norm and international telecommunications services were severely limited and very expensive. To ensure the success of INTELSAT, it was granted a virtual monopoly over the almost sci-fi space-based telecom services, and the Organization was imbued with unprecedented privileges and immunities. That was then and this is now.

Today, satellite communications is not only a proven successful technology, but it has become a commonplace fixture for both public and private interaction. Not only does it provide the infrastructure for global voice and data transmissions, but it is now widely available for Direct-To-Home video services. In the same time frame telecommunications services, generally, have gone from the province of predominantly state-owned monopoly entities to a market-dominated by private competitive operators providing an increasing variety of market (consumer) driven services at ever lower prices. The Cold War is over, and the capitalist western ideology is king. The geoeconomic market has triumphed over geopolitics.

In the face of our brave new world order, INTELSAT has become an anomaly --a government sponsored and protected commercial entity enshrined with unique status and increasingly burdensome bureaucratic operational structures. What's a body to do? Rebel, of course, and recreate itself to meet the requirements of today's radically transformed market and consumer landscape.

INTELSAT RESTRUCTURING PROPOSALS

At its Nineteenth Assembly of Parties meeting in November, 1994, INTELSAT established a Working Party whose stated purpose was to "continue the analysis of the mission of INTELSAT and development of options for INTELSAT's future with the primary objective of reaching specific recommendations for the future structure of INTELSAT."[1]

From December, 1994 to June, 1995 the INTELSAT Working Party (WP) met six times, reviewed more than fifty document submissions and produced a report to the August, 1995 meeting of the Assembly of Parties (AP). The WP also had the support of an outside consultant, NM Rothschild and Sons, Ltd., of London, and the results of an in-depth questionnaire responded to by INTELSAT Parties, Signatories and Investing Users which covered issues regarding the long-term, future structure of INTELSAT.

The WP considered a wide variety of restructuring options ranging from minor changes (e.g., multiple national Signatories and de-linking investment from system use) to full-scale privatization of INTELSAT (e.g.,as a single entity or multiple entities). The WP agreed by "consensus" that the most promising future INTELSAT structure would be the "commercial subsidiary" model which might be formed, perhaps without change to either of the INTELSAT Agreements, providing the continuation of INTELSAT in its current form while allowing for the formation of a commercial subsidiary/affiliate (INTELSAT S/A).

The main features of the commercial subsidiary/affiliate (S/A) option are as follows:

- INTELSAT is unchanged - including the inter-governmental Treaty and Board structure. It builds capacity and/or leases capacity from the subsidiary and/or external sources in order to provide "Reserved Services" (e.g., IPSN); the subsidiary is excluded from providing space segment capacity for such "Reserved Services" other than to the parent under a Service Agreement but is free to pursue opportunities for sale of space segment capacity for other uses outside of "Reserved Services";

- although INTELSAT owns 100% of the subsidiary when it is established, the launching of satellites by the subsidiary is funded by external investors in the subsidiary who dilute INTELSAT's share of the subsidiary and provide funds to repay any start-up costs (INTELSAT may eventually have no financial interest in the subsidiary);

- to the extent that new satellites are launched by the subsidiary rather than by the Parent, Signatories are relieved of mandatory investment obligations; this role is assumed instead by lenders and by the external investors in the subsidiary, who could, of course, include Signatories (INTELSAT investors would have a priority right but no obligation to invest in the subsidiary);

- a Golden Share in the subsidiary, which INTELSAT owns and controls indefinitely and irrespective of further funding of the subsidiary, prevents changes to key statutes of the subsidiary without INTELSAT approval.

Nonetheless, the WP also agreed that no definitive decisions could be taken with regard to recommending implementation of this option until the precise details of such an option were more fully developed and subject to exhaustive study. Therefore this option is to be given the "highest priority" for future study by the next incarnation of the WP, while allowing for consideration of the other options.

The Twentieth Assembly of Parties (AP-20) met in Copenhagen, Denmark, August 22-25, 1995 to review the report and recommendations of the WP. The Assembly narrowed the list of options from six to one (the INTELSAT S/A approach), decided to reconvene the WP for another year and instructed it to make final specific recommendations to the next AP, scheduled for April, 1997. The new WP is entitled "INTELSAT 2000 Working Party" ("IWP") and has the following schedule: First Meeting (October 12-13, 1995); Second Meeting (December 13-15, 1995); Third Meeting (April 10-12, 1996); Fourth Meeting (June 12-14, 1996); Fifth Meeting (September 18-20, 1996); and Sixth Meeting (December 11-13, 1996).

The efforts of the various INTELSAT Working Parties have been based on a series of assumptions regarding both the future of the international satellite communications market, INTELSAT's market and the likely success of various Options considered by the INTELSAT consultant. The WP was provided with a set of assumptions -- often presented as conclusions based on some scientific management process -- about the future of the satellite communications marketplace which led the WP inevitably toward a seemingly suitable Option for restructuring INTELSAT. To the extent that these assumptions are flawed at any point, so too are the subsequent market assessments and, more importantly, the appropriateness of any given Option. Let us make our visit.

TO RESTRUCTURE OR NOT TO RESTRUCTURE: IS THERE A QUESTION?

Although to the casual observer it may seem obvious that a reformation of INTELSAT is long overdue -- if for no other reason than to bring it in line with the transformed telecommunications landscape of the 1990s and beyond -- nevertheless, the question remains: How far, how fast and by what means? While the increasingly robust competitive marketplace in which it finds itself would suggest that nothing short of a full-blown privatization and divestiture (including the termination of its intergovernmental Treaty status) will suffice, INTELSAT is hell bent on keeping the Treaty and creating an affiliate/subsidiary (INTELSAT S/A) to conduct its "competitive" ventures.[2]

The merits of this more moderate transformation aside (the final section of this paper analyses this issue), INTELSAT faces a daunting procedural legal hurdle to establishing the S/A. Simply stated, the issue is whether INTELSAT can undertake this restructuring without *amending* the Treaty. This question is critical because it appears that the INTELSAT Treaty amendment process is cumbersome and likely to fail. Article XVII of the Treaty provides a mechanism for amending the Treaty which requires Signatories to ratify an amendment within eighteen months of its approval by the Assembly of Parties. INTELSAT's Management has already concluded that this time limitation effectively precludes the use of the amendment process. The Inmarsat Treaty land mobile amendments have been pending for six years, since their adoption by the Inmarsat Assembly of Parties (Inmarsat does not have similar time limitation in its Treaty) with no end in sight. INTELSAT tried to avoid this dead end by proposing to amend its Treaty's amendment procedure but has not received the necessary ratification's.

So INTELSAT came up with a clever scheme to circumvent this requirement altogether.[3] It set about to "prove" that it has no alternative means to fulfill its primary mission except through the creation of the INTELSAT S/A. Presto, it's legal without the need to ratify an amendment! Using a respected, though arcane, treaty interpretation known as the "teleological approach" INTELSAT's Management hopes to gloss over the Treaty's requirements for amendments and thereby declare that anything goes. The teleological approach to treaty interpretation (as opposed to the textual approach, historical interpretation and the subjective approach) emphasizes the object and purpose of the organization when interpreting its treaty. Under this theory an interpretation which is necessitated in order to achieve the object and purpose of a treaty is preferred. The INTELSAT Treaty states that the "prime objective" of INTELSAT is:

> [T]he provision, on a commercial basis, of the space segment required for international public telecommunications services of high quality and reliability to be available on a nondiscriminatory basis to all areas of the world.

Article III (a)

The "express powers" of an international organization are those specified in its constituent treaty. INTELSAT has no express power to create the INTELSAT S/A. Therefore, we turn to "implied powers," those which may be reasonably deduced from the purposes and functions of the organization. INTELSAT's Management has orchestrated a campaign intended to demonstrate that INTELSAT has no alternative means to fulfill its primary mission except through the creation of an INTELSAT S/A. INTELSAT's outside legal counsel summarized the issue as follows:

> The critical legal issue thus turns on the critical commercial issue. If INTELSAT, as presently organized, can continue to achieve the objectives of Article III, its competence to pursue a commercial subsidiary approach can be questioned sharply. However, if organizational change is 'necessary' to achieve the 'prime objective' of Article III, opposition arguments have far less sting....It should be recognized, however, that the restructuring plan is considerably removed from INTELSAT's original functions as envisioned by the Agreement, requiring an objective and considered review of long-term viability essential to the exercise of implied powers.[4]

Thus, the legal issue -- whether INTELSAT can properly create a corporate affiliate to handle its competitive services -- turns on the question of INTELSAT's continuing commercial viability. To address this issue, INTELSAT hired a financial advisor, NM Rothschild and Sons, Ltd., last year to aid the previous Working Party (Rothschild has since been re-hired to assist the current Working Party, and EDS/A.T. Kearney has been hired as a market advisor, in part to confirm Rothschild's previous findings). As expected, Rothschild found that INTELSAT's current organization is fatally flawed and will lead to INTELSAT's demise early next century. These conclusions were the result of a two part assessment by Rothschild: a questionnaire sent to INTELSAT Parties, Signatories and Investing Users and independent market research. Despite the fact that only 39% of INTELSAT member countries responded to the questionnaire at all and all three groups (the responding Parties, Signatories and Users) were "uniformly satisfied with INTELSAT", Rothschild concluded that "market share loss would eventually more than outweigh growth in the total market.[5]

Although the questionnaire and the reports analyzing its results are sizable, a brief critique follows in the next section. As discussed below, the errors in the methodology and conclusions are legion and cannot fairly be used to demonstrate that INTELSAT can no longer achieve its prime objective.

CRITIQUE OF INTELSAT'S ANALYSIS OF THE FUTURE INTERNATIONAL SATELLITE MARKETPLACE

- Calculation of INTELSAT'S Market. Rothschild's INTELSAT market share calculation is designed to "prove" that INTELSAT's share will decline. The market share calculation is constructed in the following fashion: the overall size of the market and the level of INTELSAT competitors' traffic grow at predetermined rates (e.g., 12% and 15% per year, respectively). The difference between the size of the global market and the competitors' traffic share becomes INTELSAT's "market share". So long as the rate of overall market growth is lower than the rate of the INTELSAT competitors' growth (as it is in all scenarios considered by Rothschild) the INTELSAT market share is, by definition, *forced to shrink* each year.

- INTELSAT's Market Share for Existing Services Approaches Zero. Using the calculation methods outlined above, it is easy to "prove" that all INTELSAT existing services decline to less than 1% by the year 2024. This "fact" is driven, as noted above, by the assumption that INTELSAT competitors can grow their market share faster than the total market expands over an entire 30-year period. While it is possible to draw such a conclusion during the competitors' early stages of development and market penetration when each new customer represents a significant increase in traffic, it is far more logical to assume that competitors' market share levels off as they mature. This would reflect the experience in the United States where initial double-digit market growth for AT&T's long distance competitors, e.g., MCI and Sprint, has since slowed and leveled off.

- Need to Test Other Market Sensitivity Assumptions. Contrary to the assumptions put forward by the consultant, if one tests the market so that the competitors to INTELSAT grow slower than the total market, the results are reversed and INTELSAT becomes larger. Equally, if INTELSAT grows at a fixed rate (e.g., 10%) and competitors receive the residual traffic, absolute *declines in INTELSAT traffic never happen* and its market share declines much more slowly than in the consultant's scenarios.

Such an outcome is consistent with the 1994 INTELSAT Strategic Plan (BG-101-34) which addresses in considerable detail INTELSAT's "Business tactics [which] serve to position INTELSAT to respond competitively and *profitably* to market growth opportunities and to minimize real or *perceived* competitive weaknesses. Many of these actions are reinforced by the 1994 Management Incentive Program." This business plan is borne out by financial forecasts which illustrate INTELSAT gross revenues growing from $705 million in 1994 to $1,279 billion in the year 2002.

- Assumptions Regarding Competitors Growth. Most of the assumptions regarding INTELSAT's presumed inability to compete against private-sector competitors have chosen to overlook relative asset strength. The World Satellite Directory indicates that by 1997 INTELSAT will have between 1281 and 1683 transponders (36 MHz equivalent) while private competitors will have only between 192 and 288 transponders. These numbers are borne out by Euroconsult which indicates that by 1998 INTELSAT will have 40% of *all* worldwide transponder capacity while private competitors will have but 5%. Indeed, it is difficult to construct a scenario, based on transponder capacity, which even partially supports the consultant's forecast of mid-term market demise for INTELSAT.

Moreover, it is clear that INTELSAT has sufficient capacity to grow. For whereas the consultant depicts INTELSAT as currently operating at approximately 90% to 95% of system capacity, INTELSAT itself (BG-101-34) notes its intent to gradually increase its system capacity from 61% to 65% over the next five years and 70% over the longer term. INTELSAT's Management has made no attempt to reconcile the radical difference in these loading figures. Can this be an oversight?

- Assumption of INTELSAT Inaction. The assumptions about a decline in INTELSAT market share are further put at risk by the related assumption that INTELSAT is unable or unwilling to react effectively in the face of substantial market inroads made by competitors. This assumption is wrong for two reasons. First, INTELSAT has already repriced services in response to competitive pressures in many existing market segments. Second, INTELSAT inaction is inconsistent with INTELSAT plans. The INTELSAT 1994 Annual Report describes INTELSAT's plans to launch 14 state-of-the-art satellites over the following 3 years, each satellite will have an expanded capacity over current facilities and carry a life expectancy of about 18 years. These satellites thus would last until 2010 - 2015, well into the decline of INTELSAT's demand in the consultant's scenarios, and contradict the assumption that INTELSAT cannot or will not react or that INTELSAT has lost its ability to confront market challenges.

- INTELSAT: Tiger or Pussycat? As noted above, the consultant has presented a picture of an INTELSAT that cannot respond to market challenges and that permits its market share to erode to less than 1% by 2024. On the other hand, the consultant concludes that an INTELSAT subsidiary will be able to penetrate new market services and capture at least 25% of these new markets over the same period of time. It is not entirely clear what would turn current INTELSAT into such a weakling while its subsidiary becomes an overnight Goliath.

- Quantitative Response. Although there were 77 replies to the Questionnaire, representing 81% of traffic, the majority of INTELSAT member countries did not participate in the Questionnaire. Most of the countries that did not respond are smaller nations dependent upon INTELSAT for "lifeline" service. Failure to receive specific views from these "lifeline" users may well have distorted the consultant's subsequent interpretation of the

Questionnaires' "conclusions" and led to results that do not take into consideration the needs of developing countries and smaller users. Moreover, the responses to specific questions were dealt with by only a fraction of the total respondents. For instance, questions about international video traffic had only 21 respondents. Yet, based on this modest response the consultant concluded that INTELSAT's share of video traffic would decline from 66% in 1995 to less than 1% by 2024.

CONCLUSION

INTELSAT'S 1994 Working Party considered nine Options for the future of INTELSAT. The 1995-96 Working Party is now focused on refining one Option -- INTELSAT S/A. While even this task entails considerable effort, for example, defining the respective market segments to be served by "parent INTELSAT" and "INTELSAT S/A", finding a suitable national jurisdiction for INTELSAT S/A's incorporation, and developing transition arrangements, the exercise appears to be seriously misdirected. The underlying market analysis discussed above is often inadequate, the results skewed and the conclusions unsupported by the facts. Although the proposed reconstituted dual- headed INTELSAT would no doubt give the organization greater flexibility, it is precisely this advantage which would serve to further undermine competitive alternatives. A particular danger poised by this paradigm is the spectre of INTELSAT leveraging its current *de jure* privileged status into a continued *de facto* dominance for the INTELSAT S/A. It provides the opportunity to engage in a sort of shell game, shifting costs, market power and privileged market access arrangements under the guise of creating a private competitive entity. What the world needs now is better, lower cost truly universal telecommunications services not a renewed Treaty INTELSAT. But institutions, particularly government bureaucracies and monopoly commercial entities are self-perpetuating and rarely (if ever) voluntarily permit their dissolution. Only an outside force can bring this about and the INTELSAT Assembly of Parties guided by the INTELSAT Management unfortunately appears to lack the requisite will.

Postscript: A Modest Proposal

All hope is, of course, not lost. Not yet. The current WP has a full year to offer its vision for INTELSAT's future. Although barely discussed in the Working Party's previous incarnation, there was a proposal (Options 3A and 3B) to fully privatize INTELSAT. The proposal took two forms: Privatize as a single entity or privatize as multiple entities. Therefore, in an effort to provide a brief description and assessment of these two approaches, this paper offers a thumb-nail sketch. What follow are specific recommendations as to what an INTELSAT restructuring should look like, in both the "at least two private spin-offs" and "only one private spin-off" scenarios. It also assumes (though recommends against) the continued existence, because of political pressures, of a Treaty INTELSAT "remnant" (INTELSAT ISO), which would be the same under either scenario:

The ISO portion of INTELSAT would:

- be restricted to PSN services (as defined by the U.S. government in the separate satellite decisions) and the acquisition of PSN capacity from the INTELSAT private "spin-offs" or any other company;

The privatized portion of INTELSAT would:

- have no INTELSAT ISO investment, and no sharing with, or provision by, the INTELSAT ISO, of employees, facilities or services;
- have no cross-ownership or interlocking directors;
- have no governmental privileges and immunities;
- be subject to the regulatory oversight and antitrust laws of the U.S.;
- be subject to national licensing authorities for orbital slots;
- be a publicly traded stock corporation. This transition can take place in s few as three months; in no case should it stretch out longer than a year.

In practice, the Assembly would have to approve the identification of the INTELSAT assets to be transferred to the new private company(s) and the financial information to be made public regarding those assets. (INTELSAT maintains detailed financial information on its capital assets -- the initial capital outlay and the amount of capital returned to Signatories -- virtually per satellite.) Public subscription would be invited on this basis, as well as with regard to the business plans generated by the new corporations. Corporate costs during this start up period would be born by participating Signatories.

If there are at least two spin-offs:

- At least fifty percent of the ownership interest in the newly created entities should be held by the public as soon as practicable. ("The public" does not include existing INTELSAT Signatories investing in the newly created entities.)

A restructuring that results in fewer than two spin-offs is worse than no restructuring at all. (The same conclusion applies to the creation of an INTELSAT S/A). The difficulty, if not impossibility, of relying on a regulatory structure rather than the market to force competitive action has been demonstrated by the Inmarsat I-CO single affiliate. In order to ensure a competitive market for the "spin-off" and make it a less-affiliated spin-off, it has to face another entity of equal size and Signatory ownership.

Problems with only one spin-off:
A single successor entity would exercise *de facto* monopoly market power globally without even the oversight theoretically afforded by the Assembly of Parties. For example, information about its internal accounting could be made unavailable through the selection of an "appropriate" country of incorporation. A single spin-off would carry the mantle of being the "new INTELSAT" This not only gives it incomparable advantages in the marketplace, but also gives the INTELSAT Signatory owners a clear motive to ensure that entity success above other private companies, and thus the opportunity for collusion. This is exactly what has already started to happen in the I-CO example.

Advantages of multiple spin-offs:
In contrast, creating multiple spin-offs incorporated in different jurisdictions, with different ownership, greatly lessen the anticompetitive problems associated with oversight of a single dominant provider. Multiple separate corporations would require countries to face the realities of open market access. It would be extremely difficult for a country to distinguish between properly configured INTELSAT spin-offs and separate systems (U.S. or otherwise) on any sustainable basis -- political, economic or trade.

Positive repercussions in domestic telecommunications regimes are likely. While a traditional PTT could interconnect with multiple satellite systems and maintain a position as sole national supplier of telecommunications services, this model becomes increasingly tenuous in the aftermath of the disassembly of the *de jure* international satellite monopoly. The subsequent transformations of domestic telecommunications regimes will benefit all users economically, while encouraging democratic growth. And after all, isn't this what communication is all about?

ENDNOTES

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(1) See Report of the INTELSAT 2000 Porlamar Working Party of the Twentieth Assembly of Parties, AP-20-11, at P.1, June 27, 1995.

(2) Although the discussion is referenced to in terms of one S/A, because more than one S/A is also under consideration, the text should also be read in the plural.

(3) Inmarsat, in contrast, has been able to avoid the legal niceties of the amendment process by offering its land mobile services on an "ancillary and incidental" basis. Today these services account for more than 30% of Inmarsat's revenues. Aside from the dubious legal status of such "incidental" activities, Inmarsat did not have to transfer significant assets to a separate corporation or launch special satellites to provide its land mobile services.

(4) INTELSAT 2000 Working Party, IWP-1-9 L/10/95, Attachment No. 1 at P.26, March 29, 1995.

(5) Report of the INTELSAT 2000 Porlamar Working Party to the Twentieth Assembly of Parties, AP-20-11, at PP. 5-6, June 27, 1995.

THE PRIVATIZATION OF INTELSAT: A USER PERSPECTIVE

Timothy S. Shea
Keystone Communications Corp.
Washington, D.C., U.S.A.

1. ABSTRACT

This paper will examine the privatization of INTELSAT from the perspective of a user of international space segment facilities. To date, the debate within the United States on the privatization of INTELSAT has largely been a debate between alternate suppliers of international space segment. This paper will attempt to broaden the debate, providing a users perspective on the potential benefits of privatizing INTELSAT and critiquing some of the more radical proposals to break up INTELSAT.

OVERVIEW OF INTELSAT's PRIVATIZATION INITIATIVE

Over the course of the last two years, the initiative to privatize INTELSAT has gathered momentum. In September of 1995 the INTELSAT Assembly of Parties (AP) decided to create the INTELSAT 2000 Working Group and instructed the working group to pursue a course of study that will result in proposals for the implementation of a commercial subsidiary. The text of Assembly documents are tedious at best, but the intentions of INTELSAT's membership, as enunciated in various AP documents, are fairly clear:

a) create a commercial subsidiary to provide what I will term "competitive" services (e.g., video and VSAT) that are not directly linked to INTELSAT's primary mission of providing international public switched network services: and

b) preserve the ability of INTELSAT to meet its primary obligations which clearly include international public switched network services;

With the AP's September decision, INTELSAT has sent a clear message to the world that it does intend to privatize a portion of its activities through the creation of a commercial subsidiary. Considering the bureaucratic treaty organization structures that govern INTELSAT, this author is amazed at the progress towards privatization that has been accomplished to date.

It is important to note that decisions on INTELSAT's future structure will be made by the AP. The AP consists of representatives of sovereign nations are Parties to the INTELSAT Agreements. The majority of these countries continue to provide telecommunications services through state-owned telecommunications entities. Consensus is the usual tool for taking decisions within the AP. When a vote is required to decide an issue, voting is done under a one-country, one-vote process. Thus, the effort to create a commercial subsidiary that operates in the market on the same basis as a PANAMSAT will be subject to the authority of a group that has not embraced competition and privatization to the extent that, we in the U.S., have embraced these concepts.

Considering the composition of the AP, it is hard to imagine how the privatization effort has managed to gather support. Much of the credit for the current momentum towards privatization can go to COMSAT which publicly endorsed the total privatization of INTELSAT in 1994. Under the tenure of Bruce Crockett, COMSAT, the largest investor in INTELSAT, has aggressively pursued a pro-competitive privatization policy within the INTELSAT organization, while simultaneously seeking the support of the U.S. Government for the privatization of INTELSAT. COMSAT's initial drive towards privatization, combined with the subsequent leadership of the U.S. government resulted in the AP decision to seek recommendations to implement a commercial subsidiary.

USER PERSPECTIVE ON PRIVATIZATION

As a provider of international broadcast services, the privatization of INTELSAT will have a direct impact on our (Keystone Communications) ability to provide international services to our customers. Through a combination of four teleports with 38 antennas, microwave facilities, fiber links, studios, and space segment we provide our customers with a broad range of both domestic and international broadcast services. Today Keystone holds long-term contracts on approximately sixteen 36 MHZ equivalent international transponders, most of which are on INTELSAT satellites. It is vital to Keystone, and to the international broadcast community, that any privatization of INTELSAT leave intact the ability of a privatized INTELSAT to provide global broadcast services, while at the same time ensuring that service become more responsive to customer requirements.

In addition to user requirements for a global system there are three fundamental questions that must be asked both by users of INTELSAT and policy makers with regard to the creation of a commercial subsidiary of INTELSAT: will users benefit from privatization; will users be disadvantaged in any way by privatization; and why is COMSAT, the sole U.S. gateway to INTELSAT, supporting privatization?

BENEFITS OF PRIVATIZATION

As a user of INTELSAT space segment, Keystone is painfully aware of some of the competitive disadvantages to using the INTELSAT system. The primary disadvantages to using the INTELSAT system are the direct result of the current treaty structure of INTELSAT, including: 1) the requirement in most countries to procure space segment through a Signatory; 2) the matching order requirement; 3) the lack of accountability of INTELSAT to end-users; and 4) the high costs of using INTELSAT. In the following paragraphs, I will discuss how these disadvantages impact users.

If INTELSAT operated as a privatized commercial entity none of these disadvantages should be present. Clearly, a commercial subsidiary of INTELSAT must provide service in a manner that is more responsive to customer requirements and more similar to the evolving competition. Currently, INTELSAT is increasingly less attractive to broadcast customers. Many, if not all, broadcast customers view INTELSAT as a second rate option for delivering service. PANAMSAT's ability to pre-sell its Pacific Ocean satellite can be attributed to the fact that they provide customers with a service that is more responsive to their needs.

Benefits Users Should See From A Commercial Subsidiary of INTELSAT

1) Elimination of Signatory Access Requirements

The current requirement to access INTELSAT through a Signatory rather than directly is one primary disadvantage to using INTELSAT for non-telephony services. In most instances, the Signatory is the national telephone company. This is consistent with the international communications environment when INTELSAT was created and does not cause a problem for the provision of telephony services, because the Signatory and customer are usually one and the same. However, in the broadcast market the Signatory is rarely the provider of communications services.

The requirement for broadcast users to access INTELSAT via a Signatory negatively impacts users on a number of levels. Financially, it means that broadcast users must pay an additional mark-up on INTELSAT capacity, making INTELSAT less attractive to broadcast users. Operationally, it means that users must deal with an additional layer of bureaucracy both in ordering service and when seeking the resolution to problems. The availability of direct access to INTELSAT for users would significantly benefit users. The creation of a commercial subsidiary must ensure that users can buy space segment directly from INTELSAT.

2. Elimination of the Matching Order Requirement

The current INTELSAT operating structure was designed for delivering duplex services (telephony) between international gateways. The provision of video and other services was seen as secondary and the use of customer premise earth stations was not foreseen by the drafters of the INTELSAT agreements. Consistent with the provision of a duplex service, INTELSAT requires that two parties acknowledge the service and share in the revenue stream derived from the service. With the development of multipoint services, INTELSAT requires each Signatory in the service to participate. This requirement is referred to as a matching order.

In the provision of multipoint services and/or simplex services, the matching order is a significant disadvantage to INTELSAT and users. The matching order provision means that a multipoint service must obtain the permission, on a service-by-service basis, from multiple operating entities in multiple countries. This can be a bureaucratic nightmare in the best of circumstances. Worse than the bureaucracy is the fact that each of these operating entities is likely to demand revenue for the provision of the service, causing the total cost to provide a service using INTELSAT to become non-competitive.

When using a private commercial entity

such as PANAMSAT or Columbia, users do not need to get matching orders for each service. Rather, users simply obtain the space segment from the private entity at a negotiated rate. It is easy and straight forward to obtain space segment from private commercial suppliers. Costs to the user are based on market forces, not a price determined by what is in essence a supra-national set of rules and regulations. The creation of a commercial subsidiary of INTELSAT to provide broadcast services should allow INTELSAT to eliminate the matching order requirement -- this must be a primary goal of those involved in the privatization of INTELSAT.

3. Increasing INTELSAT's Accountability to Users

Currently INTELSAT is isolated from its non-PSTN user base. This is the result not only of the requirement for users to access INTELSAT via Signatories, but also of INTELSAT's privileges and immunities. Due to its privileges and immunities, INTELSAT cannot be held accountable by users, either in the courts or via regulatory agencies. If INTELSAT is negligent in providing service, if INTELSAT is cross-subsidizing services, or if INTELSAT were to violate anti-trust laws --- users currently have no direct legal recourse.

This shielding of INTELSAT by its privileges and immunities effects the organizations responsiveness to customers. For example, if an employee at INTELSAT were to make a negligent error that required a customer to back-off his uplink power, resulting in the customer losing antennas on the beam edge that were critical to his business plan, INTELSAT would clearly view this as a serious mistake and seek to correct the problem. But, INTELSAT would not view the error as a potential threat to the organization that must be dealt with swiftly and decisively. The result of this protection is that both the organization and its staff do not feel threatened by any actions that they make take that might adversely effect others.

A commercial subsidiary of INTELSAT must be subject to the same legal and regulatory constraints that other commercial satellite companies are subject to in their commercial activities. INTELSAT would thereby be forced to be more accountable to users and become more customer responsive.

4. Lowering the cost of using INTELSAT

Lowering costs must be a primary goal of privatization. As we have discussed there are a number of structural changes that will lower the cost of using INTELSAT space segment, ranging from eliminating the matching requirement to eliminating the need to go through Signatories. In addition, INTELSAT bears a number of costs that a private commercial entity would not be required to bear. These costs must be reexamined in light of privatization and eliminated where they do not provide a competitive advantage in the marketplace.

Currently, INTELSAT must pass on to its users such costs as: holding multiple international meetings with interpretation in three languages, providing documents in three languages, paying expatriate benefits to a significant portion of its staff, the high salaries and benefits of an international organization, etc. The privatization effort must ensure that any commercial subsidiary of INTELSAT is able to eliminate costs that do not provide INTELSAT with a competitive advantage.

NEGATIVES ASSOCIATED WITH PRIVATIZATION

The only negative that this author can see in privatizing INTELSAT via the creation of a commercial subsidiary is if INTELSAT were to be broken into three or four commercial subsidiaries of four to five satellites each. As I understand the theory, INTELSAT should be broken into multiple entities to ensure that it does not dominate the marketplace. This assumes that domination of the market place is determined by the amount of capacity that is available to a particular entity. Unfortunately, there is no validity to such an assumption.

The assumption that the amount of capacity available to a competitor equates with market dominance does not take into account technological superiority, beam coverage, antenna communities, and a broad range of other market factors. Nor for that matter does it take into account the relative size of a potential INTELSAT subsidiary compared to the size of competitive systems at the time of privatization.

One of the primary services of INTELSAT's commercial subsidiary would be the provision of video services. In the video market, dominance in the provision of satellite capacity is determined not by the number of transponders and their associated price. If this were the case Columbia Communications, which has excess capacity at extremely attractive prices, would dominate the market. Rather, market dominance results from a combination of factors. One of the most important is the community of antennas pointed at a satellite. If a space segment provider can attract a key organization, like CNN, to its space segment the resulting pool of antennas pointed at the satellite make it more attractive to other broadcast customers.

Other factors of importance in determining what satellite is dominate in the market include such things as beam coverage, size of earth stations that can operate with a satellite, and cost. It is only through a combination of these factors that a satellite can be dominant in the marketplace. Once users have a feel for these factors, the market tends to recognize the "hot bird" or dominant video satellite.

As it is important that any privatized commercial subsidiary of INTELSAT's be global in nature, we must recognize that it will have to compete for business on a global basis. Currently, the marketplace recognizes PANAMSAT as having the "hot birds" for trans-pacific and Latin American video traffic. In Asia, ASIASAT clearly has the "hot birds" for regional service. In Europe, ASTRA provides the "hot" video satellites with EUTELSAT competing hard. Any policy decisions taken on the assumption that INTELSAT will dominate the market place will be sorely misguided.

Even if you look at the question of market dominance in the simplistic terms of the amount of capacity, it is not clear that INTELSAT would dominate the market. If we assume that INTELSAT's commercial subsidiary is ready to implement service at the end of 1997, INTELSAT would have a total of 22 satellites at that time. In order to meet its primary mission, INTELSAT prime would require at least three satellites in the AOR, two in the IOR and two in the POR. Thus, at the most INTELSAT would have fifteen satellites for its commercial subsidiary, compared to the eleven that PANAMSAT is seeking to put in orbit. By more conservative estimates INTELSAT prime would require eleven of its satellites to meet its primary mission, leaving only eleven satellites for the new subsidiary.

Breaking INTELSAT into three or four entities would only serve to marginalize INTELSAT in the marketplace. Such a decision could only benefit its direct competitors -- it would not benefit users.

Why is COMSAT Supporting Privatization

As the sole U.S. gateway to INTELSAT, it is not immediately clear why COMSAT would support privatization. COMSAT currently earns significant revenue from its role as the U.S. broker of INTELSAT space segment. Nonetheless, COMSAT has supported much if not all of the measures that this user sees as necessary in the creation of a commercial subsidiary of INTELSAT.

COMSAT's support of privatization is the result of their recognition of increasing competitive pressures. Competitive pressure from fiber optic communications for the provision of telephony service and from more satellite service providers that can more easily meet customer requirements for "competitive" services. With the recognition of these facts, COMSAT has a fiduciary responsibility to its stockholders to protect their investment. COMSAT's support of privatization is nothing more or less than COMSAT trying to maximize its profits for its investors.

As an interested observer, we must still question what role COMSAT sees for itself in the new commercial entity. Clearly, until privatization, COMSAT must continue to be regulated as it is today. However, the facts do not bear out allegations of nefarious plots on the part of COMSAT to ensure that INTELSAT is provided with a more competitive, commercially oriented organization that will remain insulated from the competition by the privileges and immunities of the INTELSAT Agreement.

CONCLUSIONS

The creation of a commercial subsidiary of INTELSAT is in the interests of the user community, if the new commercial subsidiary meets certain criteria. Specifically, the commercial subsidiary should:

1) allow direct access by all users;

2) allow users to buy space segment at market costs without any matching requirements;

3) be fully accountable to end-users including ensuring that it is subject to national regulatory and legal controls; and

4) have a lower cost structure that allows it to provide less expensive service to users.

Finally, it is important that policy makers in the U.S. examine market dominance more closely than they have to date. INTELSAT is not dominant in the provision of "competitive" services. Breaking INTELSAT into multiple entities may in fact lead to the result that policy makers are seeking to avoid -- the creation of a dominant player in the international broadcast market.

PERSONAL COMMUNICATIONS SATELLITE SYSTEMS

LEN J. SPELTZ

TRW SPACE & ELECTRONICS GROUP
ONE SPACE PARK
REDONDO BEACH, CA 90278

ABSTRACT

Recent major advances in electronics have dramatically shifted the satellite paradigm: either user, sender or receiver, can move about without communications degradation. Because of this advance, geostationary (GEO), medium (MEO), or low earth orbits (LEO) can now be considered. This paper compares several proposed systems for the provision of personal communications by satellite.

TRENDS IN COMMUNICATIONS SATELLITES

Over the past 30 years, satellites have contributed greatly to communications throughout the world. The earliest applications expanded transoceanic telephony and introduced intercontinental video transmission. Later, satellites provided domestic communications services and mobile service for ships at sea. Today, because of satellites, telecommunications are available everywhere in the world but the cost for mobile communications remains high. The demand for universal personal communications is there and satellite systems can satisfy both industrialized and developing region needs. An important issue is spectrum sharing in order to ensure competition. Consumers want low cost, convenience, reliability, and high quality.

Over the years communications satellites have become larger and more complex, permitting ground antennas to become smaller and less costly. Until recently, satellite communications service has required heavy, expensive terminals and the cost and mass of these terminals have greatly limited access for most people. For example, in 1993, the most portable terminal was heavier than a laptop computer and cost $25,000. The average service cost ranged from $5 to $10 per minute. Unfortunately, these high costs placed universal satellite communication service beyond the reach of the vast majority of the world's citizens.

Extraordinary improvements in microelectronics RF technology and low-cost high-performance spacecraft have made mass access to satellite telecommunications possible. We are now able to package an entire satellite communications earth station into a hand-held telephone. These terminals can be manufactured for as little as $300 and sold for $500. Soon mass availability of satellite service will permit rates to drop to near the current price range for local cellular service. In fact, local service will be directly available to millions and cost as little as $0.65 per minute.

CONSUMER NEEDS AND CRITERIA

To be successful, a mass communication system must meet the following consumer needs and criteria:

- Low cost
    - Service rates
    - Personal telephone cost
- Convenience
    - Hand-held telephones
    - High availability
- Reliability
    - Low dropout probability
    - High probability of connection
- High quality
    - Acceptable time delay
    - Acceptable voice quality

COST

Cost is a primary issue for a mass communications service. The number of users and the usage rate are strongly dependent on service charges. Mass satellite communications service must be based on service rates that are not much higher than cellular rates.

Local celluar service providers now charge subscribers $0.11 to $0.90 per minute for service. Cellular is now servicing more than 50 million subscribers. Cellular telephones cost $100 to $1000, with the low end of the range subsidized by operators. The average telephone call is just over 2 minutes and the average subscriber uses his phone for 100 to 120 minutes per month.

A new satellite-based personal communications system must be less expensive than past mobile satellite communications systems. If the service rate is too high, the system will not attract a large enough customer base to pay back the original investment in a reasonable time. In order to be competitive, the investment cost per subscriber for future mobile personal communications satellite systems must be comparable to the investment cost per subscriber for future terrestrial cellular network systems.

TIME DELAY

A factor in space-based communications systems which deserves special attention is time delay. Talk overlap and confusion results if the one-way delay exceeds 300 msec (interaction time for two communicators would be 600 msec). The total amount of time delay is comprised of propagation delay and delay due to other factors such as vocoder compression/processing and terrestrial network transmission delay. Propagation delay is the amount of time it takes to propagate signals from the earth's surface to the satellite and back. For satellites in low earth orbit (LEO) the delay for propagation is only 5 to 10 msec. In medium earth orbit (MEO) the delay ranges from 70 to 80 msec, and in geostationary earth orbit (GEO) it ranges from 250 to 270 msec. The amount of delay time for factors other than propagation delay is 85 to 100 msec for regional calls and 140 to 180 msec for international calls. When all time delay factors are considered, the total amount required for GEO satellites will not be acceptable to subscribers.

We must also consider the nature of communications networks. If the signal passes through the satellite only once then transmission is described as single-hop. If the signal passes through the satellite twice, then the transmission is called double-hop. Each of the delay elements can be considered separately and then combined. Figure 1 shows a comparison of the time delay produced by satellites in GEO, MEO, and LEO with single-hop and double-hop transmission.

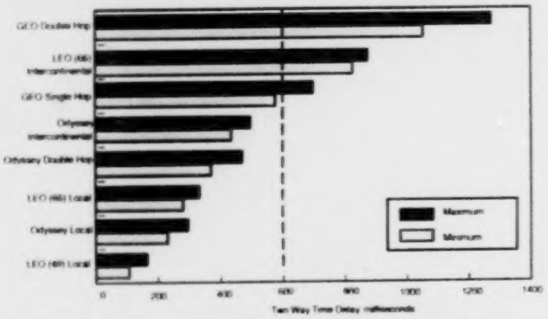


FIGURE 1. VOICE INTERATION TIME FOR SATELLITE SYSTEMS

GEOSTATIONARY SATELLITE SYSTEMS

For many years, communications satellites have been maintained in GEO so that the ground antennas could point to a fixed location. Only three or four geostationary satellites are then required to provide single coverage service to the entire world. This arrangement simplifies operational control of the satellite constellation. Unfortunately, it also causes several problems. The high GEO altitude requires a complex satellite to receive and transmit the signals from and to the desired locations on earth. The satellites are large, expensive and must be equipped with large multibeam antennas, large numbers of transponders, and extensive signal processing. Each satellite also represents a single point node failure.

In general, the characteristics of GEO satellite systems are:

- Complex, large, expensive satellites
- Large, expensive launch vehicles
- Longest time delay (generally unacceptable)
- Low elevation angles at high latitudes (low quality)
- Long development time
- Operational simplicity
- No handover requirement
- Wide area access

LOW EARTH ORBIT SYSTEMS

Several companies are pursuing large constellations of satellites in LEO to provide service to subscribers. Twenty-four to sixty-six satellites are required to provide continuous service. However, the satellites can be smaller and less expensive since less power is required to close the communications link. The total cost for these systems is quite high even allowing for the economies of scale associated with the large number of satellites required.

In general, the characteristics of LEO satellite systems are:

- High investment/replacement cost
- Large ground infrastructure
- Complicated satellite-to-satellite network control
- Shortest propagation time delay
- Low elevation angles
- Extensive handover processing
- Long deployment time

MEDIUM EARTH ORBIT SYSTEMS

MEO satellite systems provide the lowest cost per circuit year. Three factors contribute to circuit cost per year: total investment for space initial constellation and replenishments and ground segments, useful subscriber capacity, and investment lifetime. When all of these factors are taken into account, the life cycle circuit cost of MEO satellite systems is a factor of 2 to 3 less expensive than LEO systems and 30 to 40% less expensive than GEO systems.

Furthermore, MEOs reduce GEO time delay by 200 msec on each transmission or 400 msec for an interactive conversation.

In general, the characteristics of MEO satellite systems are:

- Lowest cost per circuit year
- Acceptable propagation time
- Incremental startup
- Rapid deployment (short time to market)
- High availability
- Flexible coverage
- Simple operation

COMPARISONS FOR PERSONAL COMMUNICATIONS SATELLITE SYSTEMS

Figure 2 gives a comparison of the characteristics of the three types of systems.

	LEO	MEO	GEO
Space Segment Cost	Highest	Lowest	Medium
Satellite Lifetime (Years)	5 – 7.5	10–15	10–15
Terrestrial Gateway Cost	Highest	Medium	Lowest
Hand-Held Terminal	Yes	Yes	No
Local Time Delay	Imperceptible	Imperceptible	Long
Operations	Complex	Medium	Simplest
Call Handover	Frequent	Infrequent	None
Phased Startup	No	Yes	Yes
Development Time	Long	Short	Long
Deployment time	Long	Medium	Short

FIGURE 2. COMPARISONS FOR PERSONAL COMMUNICATIONS SATELLITE SYSTEMS

LEO satellite systems reduce propagation time delay, but require large numbers of satellites and incorporate other features which produce high costs for the end user. Also, the high technology associated with LEO concepts adds both significant financial risk for the investor and also reliability risk for the end user. GEO satellites can produce unacceptable time delay. In addition, the complex spacecraft required for personal communications missions are very expensive and require an extremely long development time.

The MEO satellite system combines the best features of LEO and GEO to ensure user satisfaction (affordability and quality service).

ORBIT COMPARISONS

GEO satellites operate from orbit altitudes above the outer Van Allen radiation belt. A MEO system puts the satellites between the outer and inner Van Allen radiation belts. LEO systems operate from orbit altitudes below the inner Van Allen radiation belt. Figure 3 shows the relative altitudes of LEO, MEO and GEO systems.

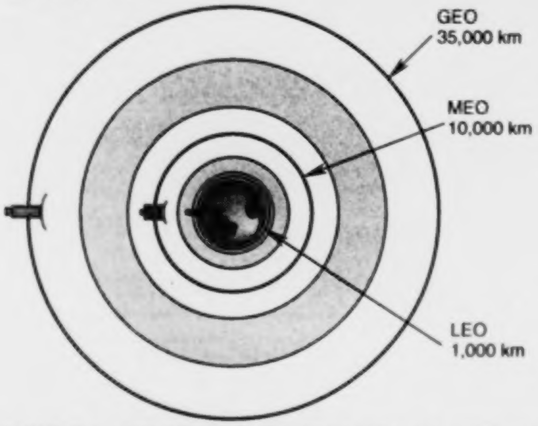


FIGURE 3. RELATIVE ALTITUDES OF LEO, MEO, AND GEO SYSTEMS

ODYSSEY IS AN EXAMPLE OF A MEO SYSTEM

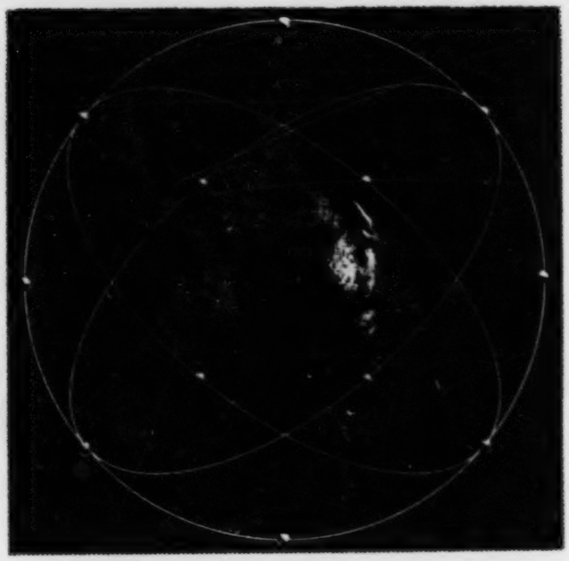
The Odyssey constellation features twelve satellites at an altitude of 10,354 km with four satellites in each of three orbit planes inclined at 50 degrees (Figure 4). Because the Odyssey constellation is relatively small, the system can be developed and launched in a short time. Figure 5 shows typical coverage of a twelve-satellite Odyssey constellation. Each satellite's multibeam antenna pattern divides its assigned coverage region into a set of contiguous cells.

A key feature of the Odyssey system is that the satellite antennas are generally pointed off-nadir to achieve the desired coverage. Coordinated pointing of the 12 satellites typically results in multiple satellite coverage of land areas, while simultaneously maintaining a high degree of single-satellite coverage of ocean areas.

ODYSSEY ARCHITECTURE

The Odyssey system will provide economical, high-quality, personal communications service to users worldwide, including voice, data, messaging and paging. Dedicated ground stations will link mobile subscribers to the public switched telephone network (PSTN). Figure 6 shows the Odyssey system architecture.

The forward communication links from the satellites to hand-held terminals are at S-band and the return links are at L-band. The back haul communication links



- 12 satellites to provide worldwide coverage
- 6-hour orbit
- Small constellation is easy to manage

FIGURE 4. ODYSSEY ORBIT CONSTELLATION COVERAGE

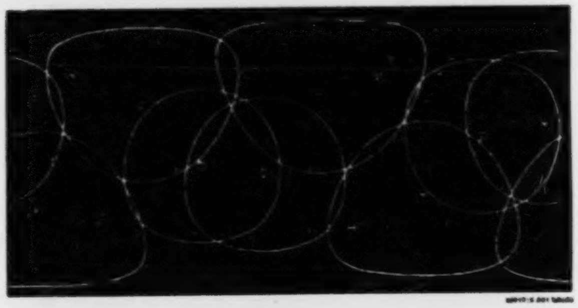


FIGURE 5. TYPICAL ODYSSEY CONSTELLATION COVERAGE

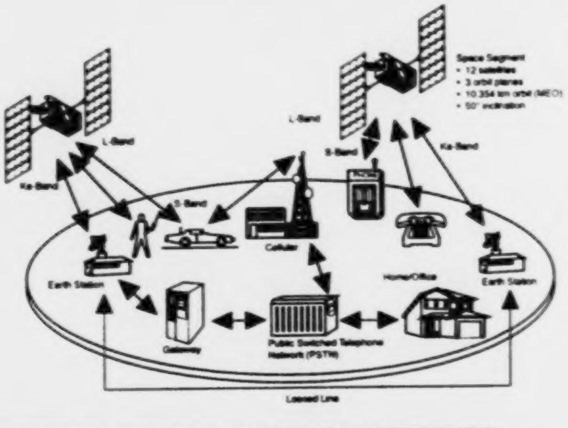


FIGURE 6. ODYSSEY SYSTEM ARCHITECTURE

between the satellites and the earth stations are at Ka-band frequencies (Figure 6). Dual-mode handsets can be connected through existing terrestrial mobile (cellular or PCS) services where available. Where they are not, the system switches automatically to Odyssey satellites. Mobile communcations will be offered in areas not covered by cellular systems.

The Odyssey system incorporates a number of unique features, foremost of which are the medium earth orbit (MEO) and directed beam steering. MEO satellites enable high-elevation viewing angles so that the link margin yields high availability of service. The fifteen-year lifetime satellites can focus the circuit capacity on the world's populated areas, resulting in the lowest cost per circuit year. The system enables significant flexibility in providing capacity to areas of greatest demand. Furthermore, Odyssey satellites can easily coexist with other systems sharing the spectrum.

In comparison to other proposed systems, Odyssey clearly offers the best quality service and overall economies. TRW filed with the Federal Communications Commission in May 1991 to provide service in the United States. In November 1994, TRW and Teleglobe announced a joint venture to build and operate the Odyssey system. The FCC granted the company a construction permit in early 1995. Service operations are scheduled to begin in 2000.

SPACECRAFT

Figure 7 shows the Odyssey spacecraft configuration. The spacecraft design employs three Ka-band antennas which are gimbal mounted and independently pointed towards earth. The spacecraft points the S-band and L-band antennas by body steering. Solar arrays are kept pointed toward the sun by single-axis drives. The satellites can be launched one or two at a time on conventional launch vehicles.

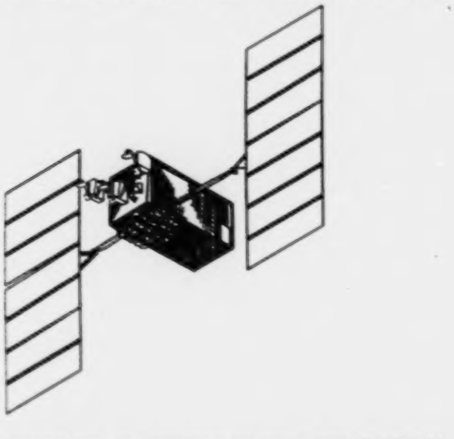


FIGURE 7. ODYSSEY SPACECRAFT CONFIGURATION

IGH AVAILABILITY DUE TO HIGH-ELEVATION ANGLES AND BEAM POINTING

Figure 8 shows the cumulative probability of satellite elevation angles as viewed by a subscriber on the ground. Elevation angles for the Odyssey system are much higher than LEO systems. The average elevation angle for Odyssey is more than 50 degrees and the minimum elevation angle is more than 20 degrees. This compares to an average elevation angle of 25 to 30 degrees and a minimum elevation angle of 8 degrees for the lowest altitude LEO system. The Odyssey average elevation angles are about 15 degrees higher than the ICO system.

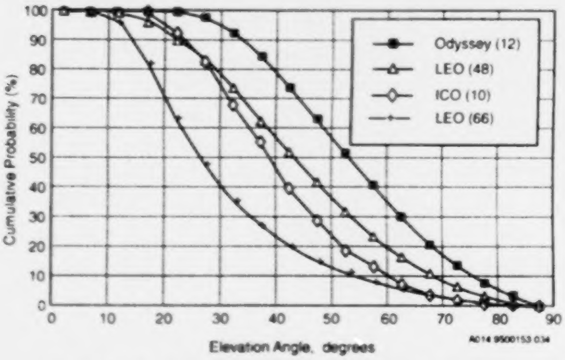


FIGURE 8. ELEVATION ANGLE COMPARISON OF PROPOSED MOBILE SATELLITE SYSTEMS

The higher elevation angles are a major user benefit. The Odyssey system is less vulnerable to tree, building, and terrain blockage and less margin in the communications link budget is required. Beam pointing minimizes the number of satellites required for high-quality communication.

CONCLUSIONS

LEO satellite systems reduce propagation time delay, but require large numbers of satellites, which in turn produce high costs for the end user. The complex technology associated with these concepts adds both significant financial risk for the investor and also reliability risk for the end user.

GEO satellites produce unacceptable time delay. In addition, the complex spacecraft needed to carry out personal communications are very expensive to build and require an extremely long development time.

MEO systems represent the best combination of features to ensure user satisfaction, low cost and high communications quality. Using conventional satellite and terrestrial technology, Odyssey, the TRW MEO system, reduces risk and minimizes costs by using a relatively small number of satellites to provide personal communications service to the entire world.

REFERENCES

1. "Comparison of Personal Communications Satellite Systems," Roger J. Rusch, TRW Space & Electronics Group, Redondo Beach, CA, Satellite XII, 12th Annual International Conference & Exhibition, Washington, D.C., February 24-26, 1993.

2. "Odyssey Personal Communications Satellite System," Christopher J. Spitzer, TRW Space & Electronics Group, Redondo Beach, CA, PTC '93, 15th Pacific Telecommunications Conference, Honolulu, Hawaii, January 17-20, 1993.

3. "Odyssey, A Constellation for Personal Communications," Roger J. Rusch, Peter Cress, Michael Horstein, Robert Huang and Eric Wiswell, TRW Space & Electronics Group, Redondo Beach, CA, 14th AIAA International Communication Satellite Systems Conference & Exhibit, Washington, D.C., March 22-26, 1992.

4. "Odyssey, An Optimized Communications Satellite System," Roger J. Rusch, TRW Inc., 15th AIAA International Communications Systems Conference, San Diego, California, February 20-March 3, 1994.

5. "Odyssey–Personal Communications of the Future," Paul R. Mock, TRW Inc., IEEE 1994 National Telecommunications Conference, San Diego, California, May 16-22.

ADVANCED MODULATION TECHNIQUES FOR DIGITAL SATELLITE MODEMS

Henry Stewart and Rick Cannon
EFData Corporation
2105 West 5th Place
Tempe, Arizona 85281 USA

ABSTRACT

Advanced modulation techniques have historically not been used in satellite communications systems because of inherent satellite power and bandwidth limitations. New coding approaches combining pragmatic trellis and Reed-Solomon techniques have reduced the *Eb/No* requirements to practical levels. Simulation and test results indicate that 8-PSK and 16-QAM modulations are practical techniques to increase the data rate capability of a satellite channel.

INTRODUCTION

The history of digital communications has been marked by a constant quest for higher data rates and lower bit error requirements to meet the dramatically increasing demand for communications services such as compressed digital television. Terrestrial services are meeting this demand by installation of high capacity fiber optic systems and by the use of complex modulation schemes to carry more information over a given bandwidth.

Digital satellite systems historically have not been able to match the bandwidth efficiency gains of the terrestrial systems because of a power and bandwidth limited operational environment. Simple, noise immune modulation schemes combined with convolutional error correcting coding are common practice in satellite systems to provide a circuit with acceptable error performance.

Recent design improvements in conjunction with the plummeting cost of digital technology have made satellite modems practical that utilize more advanced modulation techniques.

This paper describes the use of 8 state phase shift keying (8-PSK) and 16 state quadrature amplitude modulation (16-QAM) in satellite modems. These modulation techniques combined with powerful trellis and Reed-Solomon block coding result in systems that can operate in current satellite environments and provide high bandwidth efficiency, low error rate, high speed communications channels.

DIGITAL MODULATION

Satellite communication links are characterized by a very power and bandwidth limited operational environment. This contention for resources results in operation near saturation with associated phase and amplitude distortion. The links are an analog radio relay in space possessing a set of unique limitations. Geosynchronous satellites orbit the earth at an altitude of approximately 35,784 km and derive their transmission power from solar cells. The typical path loss of 200 dB combined with limited satellite power puts constraints on the usable types of modulation. Receive carrier to noise ratios are typically in the range of 5 to 15 dB, which constrain the choice of modulation.

Bipolar phase shift keying (BPSK) and quadrature phase shift keying (QPSK) have historically been the most popular modulation methods for digital satellite communications. They present an excellent compromise between bandwidth efficiency (bit/sec/Hz) and *Eb/No* (energy per bit to noise spectral density ratio) performance. They are also fairly insensitive to link impairments such as phase noise and amplifier non-linearity.

Figure 1 shows constellation diagrams of various modulation methods. Since a BPSK signal can take one of two values, it can carry 1 bit of user data for each transmitted symbol interval. Conversely, QPSK carries 2 bits of user data for each transmitted symbol. The transmitted bandwidth is further reduced by grouping a greater number of data bits together into symbols via a process generally referred to as higher order modulation.

One method of increasing bandwidth efficiency is to leave the amplitude constant and increase the number of possible phase states per transmitted symbol. 8-PSK contains 8 states, or 3 bits per symbol and 16-PSK contains 16 states or 4 bits per symbol. Another technique of increasing bandwidth efficiency is to vary both the phase and amplitude using the modulation technique called quadrature amplitude modulation or QAM. Figure 1 also illustrates 16 states in a rectangular grid called 16 QAM.

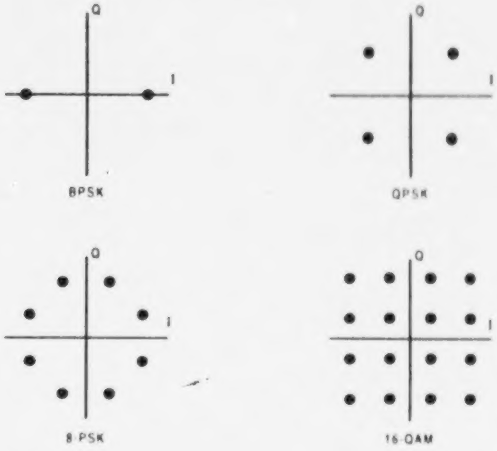


FIGURE 1: Modulation Types

The constellations shown in the figure all occupy the same bandwidth (after comparable Nyquist filtering), but have varying efficiencies of 1 through 4 bit/sec/Hz. The higher order modulations contain a "cost" of increased signal power requirements for a given bit error rate. Figure 2 compares the ideal uncoded bit error rate performance for various modulation techniques. At a given error rate 8-PSK and 16-QAM require approximately 4 dB more *Eb/No* than QPSK, while an additional 4 dB is necessary for 16 PSK. This power penalty is the reason that higher order modulation was previously avoided for satellites.

CHANNEL CODING

Satellite systems rely on some of the most powerful known error correction techniques to combat the effect of low *Eb/No*. They are typically designed for worst case error rates of 1×10^{-6} for voice grade service and 1×10^{-10} for high reliability data service. An uncoded QPSK voice grade service requires an *Eb/No* of about 11 dB to meet error goals, with higher order modulations requiring even higher *Eb/No* values. Convolutional encoding and Viterbi decoding (K=7, rate 1/2) reduce the *Eb/No* requirement by 5 dB, at the expense of doubling the occupied bandwidth.

Early research in higher order modulation coding schemes focused on designing a custom, optimum codec for a particular modulation type. In 1989 Viterbi and others published a paper on the subject of "Pragmatic Trellis" decoders. The paper examined ways to use commercially available, inexpensive K=7 Viterbi decoder integrated circuits for many types of higher order modulation. The paper showed that these decoder chips could produce results within tenths of a dB of optimum. This meant that there was no appreciable advantage to using a custom decoder, the decoder being used for QPSK could work very well for numerous other schemes.

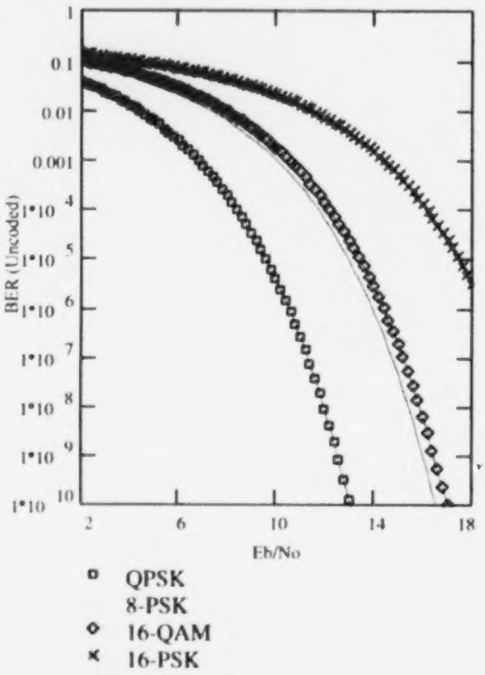


FIGURE 2: Uncoded BER

This technique renewed interest in higher order modulation for a design using 8-PSK transmitting 139.264 Mbit/sec for fiber restoral over a 72 MHz transponder.

Recent advances in coding schemes use the Viterbi technique in conjunction with a Reed-Solomon block code. This combination is called concatenated coding. Viterbi decoding works best with random input noise found in a satellite link, while Reed-Solomon correction is very good in a burst error environment. The output error performance of a Viterbi decoder is bursty in nature and works well as the input to a Reed Solomon decoder. An additional technique called interleaving limits the length of an error burst to allow complete correction. Selection of the interleaving method is critical to ensure optimum performance.

The INTELSAT standard for Intermediate Data Rate (IDR) service is an example of the power of concatenated coding. The combination of Viterbi and Reed-Solomon coding schemes reduces the error rate significantly. Figure

3 shows that voice grade service improves approximately 1 dB but 3 dB *Eb/No* improvement occurs at error rates of 1 x 10^{10}. Less than 10% increase in occupied bandwidth allows this improvement.

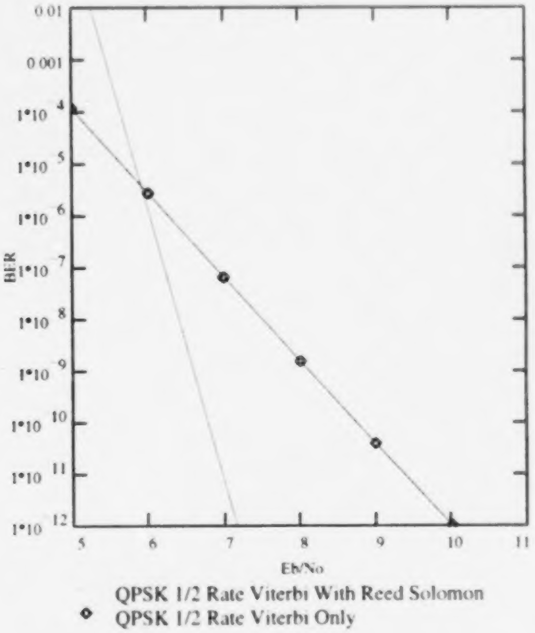


FIGURE 3: Concatenated Coding

Current generation digital satellite modems combining higher order modulation, pragmatic trellis inner coding, and Reed Solomon outer coding can replace older QPSK service and significantly increase capacity while maintaining the same service grade, especially for data applications. See Figure 4 for the improvement possible.

OPERATION

Satellite operators are familiar with QPSK/BPSK signals, and are understandably somewhat leery of 8-PSK and 16-QAM signals because of their higher sensitivity to phase noise and amplifier non-linearity. Appreciable non-linearities in either the transponder or earth station power amplifier produce excessive intermodulation which cause degradation of the transmitted signal plus interference to other users in the same transponder. In addition, excessive power usage caused by a less power efficient modulation scheme can reduce the life of the satellite batteries.

Simulation and testing of 8-PSK and 16-QAM modulations indicate that an earth station solid state amplifier output backoff of 4 to 5 dB provides sufficient linearity. TWT amplifiers exhibit an inherent amplitude to phase conversion during operation close to saturation. These TWT amplifiers should be operated with about 7 dB backoff. In either case the backoff should be increased when the amplifier carries multiple carriers.

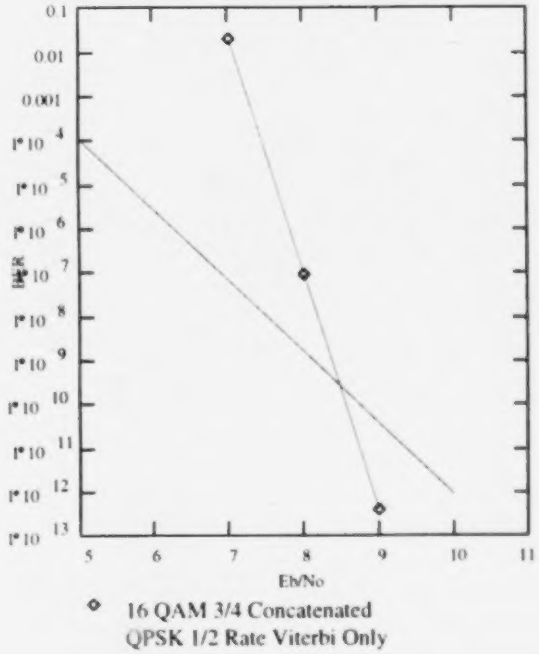


FIGURE 4: 16-QAM BER Performance

A carefully prepared link budget resolves these concerns. This link budget shows the levels expected at each point in the satellite circuit, and also provide a means for pinpointing any weaknesses in the proposed installation. A well-designed earth station with sufficient operating margin coupled with a non-degraded transponder provides a good platform for these modulation techniques.

Many places in the frequency conversion chain produce phase noise. Modulation and demodulation are typically done at intermediate frequencies below 500 MHz and must be translated to C or Ku band by up and down converters. Some older converters originally designed for wide band FM video services are inadequate for this type of modulation. In addition, there are some converters currently on the market that do not meet INTELSAT phase noise specifications and will consequently impair performance.

Demodulators track out phase noise at offsets up to a certain frequency set by the internal (Costas loop) bandwidths. This frequency is roughly 1/1000 of the data rate for QPSK but must be narrower for 8-PSK and 16-

QAM. This value can be as low as 1/10,000 of the data rate for 16-QAM. This typically limits advanced modulation techniques to data rates of 1.544 kbit/sec and higher. Phase noise requirements become less stringent as the data rate increases.

8-PSK modems generally work well with converters fully compliant with INTELSAT phase noise requirements. 16-QAM modems require somewhat better phase noise which can be met by well-designed rack mount type converters. Figure 5 shows the recommended phase noise curve for 2.048 Mbit/sec service using 16-QAM modems. The key item is the ratio of the data rate to the "corner point" on the phase noise curve. This point moves to higher frequencies in direct proportion to an increase in data rate.

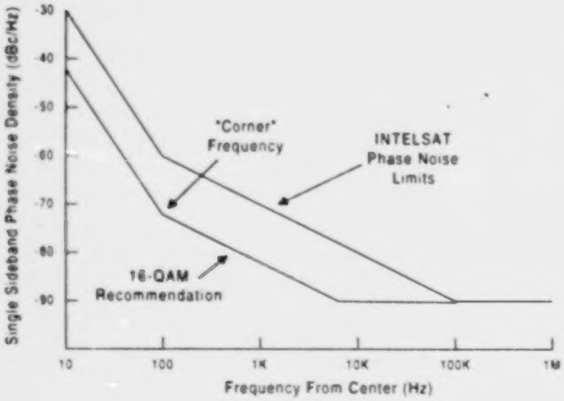


FIGURE 5: Recommended Phase Noise Limits for Carriers up to 2.048 Mbit/s

TESTING RESULTS

8-PSK modems are becoming more prevalent in the marketplace. Currently INTELSAT is in the process of defining a modulation specification to ensure compatibility between different vendor's equipment. 1×10^{-10} error rates are reached at an *Eb/No* value of less than 7.2 dB with 2/3 pragmatic trellis and Reed-Solomon coding.

16-QAM modems have recently entered the market and have successfully passed initial testing and service qualification. Results of testing are shown in the table below. The DS-2 (6.312 Mbit/s) was tested with an INTELSAT 30 watt SSPA satellite simulator and the DS-3 (44.736 Mbit/s) was tested over the air.

Data Rate	Coding	Eb/No	BER
DS-2 (6.312 Mbit/s)	3/4 Pragmatic trellis	8.0	3×10^{-6}
	3/4 Pragmatic trellis and Reed-Solomon	8.4	3×10^{-8}
DS-3 (44.736 Mbit/s)	7/8 Pragmatic trellis	10.0	1.8×10^{-7}
	7/8 Pragmatic trellis and Reed-Solomon	10.3	$<1 \times 10^{-9}$

TABLE 1: Measured 16-QAM Performance

REFERENCES

"Testing of EFData Developed 16 QAM Modem for EFData," Comsat Laboratories Internal Report, August 1994

Stewart, H. "16-QAM Modems is Satellites," Communications System Design, July 1996

Viterbi, A., Wolf, J., Zehavi, E., Padovani, R. "A Pragmatic Approach to Trellis Coded Modulation," IEEE Communications Magazine, July 1989

Transponder demand and supply in the Asia-Pacific region: How will they match over 1995-2005 ?

Stéphane Chenard
Euroconsult
Paris, France

Abstract: The Asia-Pacific region has clearly become the world's most dynamic market for communications and broadcasting satellite vendors. While the spectacular increase of transponder capacity to be expected over the next 3-4 years may seem to justify concern over market saturation, this paper presents an analysis of present and future demand for the satellite operators' two major markets, public switched telephony and television broadcasting. It appears that (1) the Asia-Pacific telecommunications market can be expected to keep growing robustly over the next 10-20 years; (2) the telecommunications market and the advent of digital video compression will keep the television industry's transponder demand around its current level; (3) there will be no excess transponder supply, and the transponder market will in fact remain tight over most of the next 10 years.

1. Transponder demand

1.1. Telecommunications

The telecommunications markets of the Asia-Pacific region[1] are experiencing unprecedented growth since the early 1980s. It is closely correlated with overall economic activity, the rise of the private sector and the frantic development of intra-regional trade. Illustration of the market's sudden dynamism abound; for instance, the outgoing international telephone traffic of Asia-Pacific countries grew at an average rate of 27.5% per year from 1984-92, over twice the annual average of 13.5% achieved in the rest of the world. This growth slowed down in the early 1990s, probably due to the growing share of short-duration fax calls as well as to the worldwide economic recession of 1991-93, but traffic is unlikely to grow by less than 15-20% per annum in the Asia-Pacific region over the next ten years.

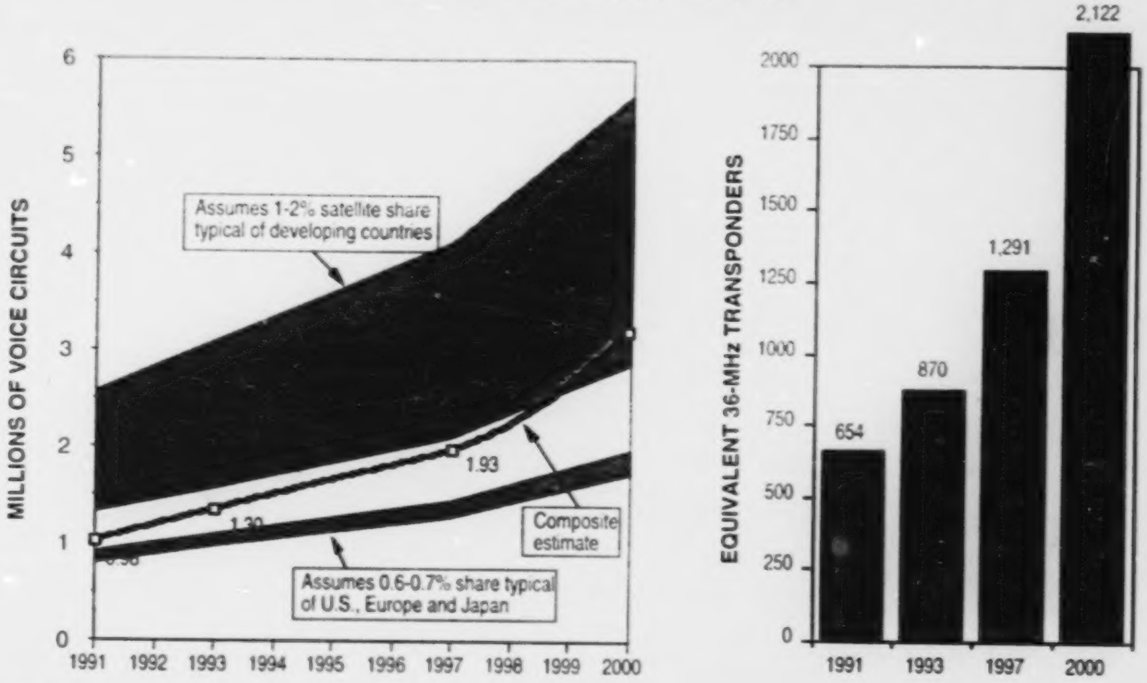
The region's telecommunications sector is likely to sustain a high growth rate through 2005, and probably longer. Telecommunications infrastructure still has a long way to go to catch up with the rest of economic development in many Asia-Pacific countries; for instance, at the current growth rates, the Asia-Pacific region's share of the world's total number of main lines will take until about 2005 to come close to its current share of the world's total gross domestic product, or about 25%. The region's share of the world's total international telephone traffic should converge toward the same value at about the same time. However, Asia's share of the world's wealth is certain to rise substantially over the next decade, setting the target higher for the development of telecommunications. The region's countries thus seem to require more than the coming decade to adjust their infrastructure to their economies.

1.1.1. Domestic networks

This growth will fuel a substantial market for satellite telecommunications. Most Asia-Pacific countries have low population densities (under 150 inhabitants per square kilometer) and low teledensities (under 20 main lines per 100 population), as well as large desert, mountain or rainforest areas, which create more favorable conditions for satellite-based telephony, at least as an interim solution, than for the rapid expansion of terrestrial networks. Moreover, a large differential is already apparent between the pace at which new lines are installed and the growth of demand. Satellite Earth stations, along with some terrestrial technologies such as wireless cellular systems, are best adapted to providing rural telephony in such circumstances, at least until the terrestrial wire networks catch up with demand.

Satellites typically support 1-2% of the circuit capacity of public switched networks in developing countries, and 0.6-0.7% of that capacity in evolved markets such as the United States, Western Europe and Japan.[2] Applying these ratios to the Asia-Pacific region's ten largest markets, and even taking into account the fact that some of the least developed will reduce their dependency on satellites in the late 1990s, the satellite capacity required to support their combined local switch capacity would grow from 960,000 voice circuits in 1991 to 3.17 million in 2000. Assuming that a 36-MHz transponder can provide

Transponder demand for public-switched telephone network (PSTN) applications in the Asia-Pacific region, 1991-2000



SOURCE: Euroconsult.

about 1,500 voice circuits, as is the case on current Intelsat 7 satellites with Earth stations equipped for digital circuit multiplication, the Asia-Pacific public telephony market's demand for satellite capacity would then grow from about 850 transponders in 1993 to about 1,300 in 1997 and over 2,100 by 2000. These figures are probably minima given that digital circuit multiplication is not extensively used on low-density traffic paths.

1.1.2. International networks

The international circuit capacity of Asia-Pacific countries is poised to grow even faster than the local switch capacity, nearly quadrupling from 114,960 circuits in 1994 to 440,000 by 2000. Capacity will thus grow by about 25% annually, generally keeping pace with demand as represented by outgoing international traffic.

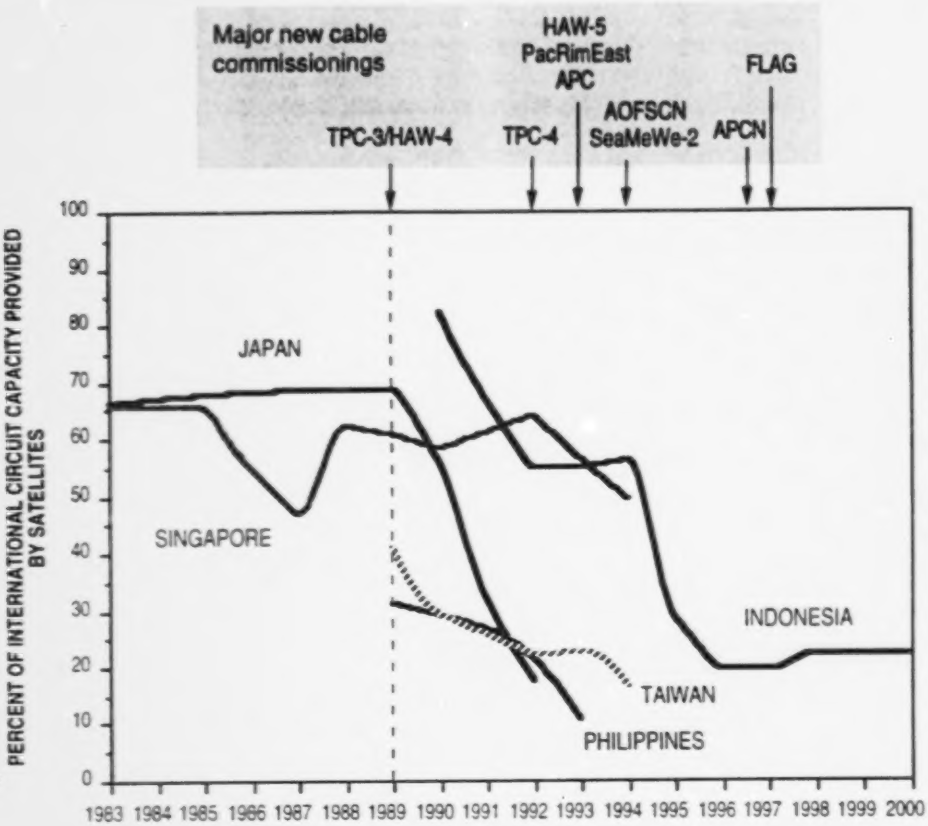
Satellite operators face overwhelming competition from undersea fiber optic networks on the international telephony market, however. From 32% in 1994, the share of satellite circuits in the capacity available for international telephony in the Asia-Pacific region is expected to fall to about 20% by 2000. For instance, trans-Pacific cables provided an estimated 220,000 voice paths between North America and Japan in 1993, compared with 83,000 on satellites. Cable capacity is projected to reach up to 1,500,000 voice paths by the late 1990s, or three to four times the capacity available on satellites on Pacific trunk routes. Trans-oceanic traffic, which remains one of Intelsat's core businesses, will shift to terrestrial carriers even faster than it did in the mid-1980s in the Atlantic Ocean region, where the balance of cables and satellites was regulated until 1988. For instance, the share of satellite circuits in Japan's international capacity has already decreased from over 65% to about 15%, while Indonesia is moving from about 80% to about 20%.

This is probably a minimum, however; the proportion of satellite circuits is expected to be higher in the more advanced trans-Atlantic market. International carriers will continue to need satellite capacity for restoration purposes and to serve paths away from fibered routes. This still leaves a substantial market, with transponder demand growing from about 25 units in 1994 to 40-60 transponders by 2000.

1.2. Television broadcasting

The Asia-Pacific region totalled an estimated 320.3 million television sets in 1992, corresponding to a

Share of satellites in the international circuit capacity of selected Asia-Pacific countries (1983-2000)



SOURCE: Euroconsult.

penetration ratio of one set for every 17 people. The region's total count of television households grew on average by 5.6% per year over 1990-93; some large markets such as Japan, Australia and Thailand are nearing saturation, but growth should remain around 5% per year through 2000, when the Asia-Pacific region would total an estimated 456 million television households.

1.2.1. Market trends

1.2.1.1. Deregulation

Economic development, deregulation and democratization, to varying degrees, have put the Asia-Pacific broadcasting market on the path to robust and durable growth. Most countries in the region, including some with extremely rigid media regulations such as China and Indonesia, are allowing privately-held television channels to eat into the audience of State-run broadcasters. The Asia-Pacific region's television advertising market grew by 4.9% on average from 1982-93, to total $18.9 billion in 1993, about as much as the entire U.S. advertising market. Except for Japan and Australia, Asia-Pacific advertising markets ignored the severe crisis which struck that sector over 1990-93, growing on average by 8.8% per year over 1992-93.

1.2.1.2. Cable and satellite delivery

Cable and satellite delivery are well developed in the region's largest market, China, and in two of its most affluent, Japan and Taiwan. They remain marginal in most other countries, but large multichannel projects are already well advanced in Thailand, Australia, South Korea and Indonesia. Altogether, an estimated 9 million homes received television directly from satellites throughout the Asia-Pacific region in 1994, 65% of them in Japan.[3]

Cable television is already closely linked with the development of telephone networks. While U.S. and European cable companies spent many years and billions of dollars in laying fiber alongside existing telephone wires and are now up against entrenched telephone operators, the shortage of telephone capacity in many Asia-Pacific countries makes television companies welcome to provide voice and video services from the beginning. As a result, the television industries of Thailand or Malaysia will leapfrog from a condition close to that of European broadcasters in the 1960s to technologies and business concepts which remain semi-operational in the United States. Some governments, such as those of South Korea, Singapore and Malaysia, are also favoring cable over satellite distribution because it allows them to recoup their investment in telephone networks and to exert closer control over program content. As a result, the number of cable homes should remain about six times that of satellite homes over 1994-2005.

However, the dish population will probably grow in all of the largest markets. Those where government policy, overwhelming competition by cable networks or insufficient per-capita revenue will effectively stifle its development, like Singapore, Australia or Myanmar, also happen to be of relatively small size. Dishes are now illegal in some countries but, with few exceptions, prohibition regimes are generally already unenforceable and will probably not remain viable over the long term. The Japanese market is still growing rapidly, and the Thai, Indonesian and Chinese markets are taking off. The prospects of direct broadcasting are less clear in Malaysia, the Philippines, Australia and South Korea, where cable distribution is either already predominant or receiving enough investment to become predominant. Overall, the Asia-Pacific region's dish population is projected to more than triple through 2005, coming to about 30 million homes.

The Asia-Pacific cable market is forecast to grow from 53.16 million households in 1993 to about 93 million in 2000 and 123 million in 2005. This would correspond to about 7% annual growth over 1993-2005, close to the 10% annual growth of cable television in the United States from 1980-92. Altogether, the Asia-Pacific region's 70 million new multimedia subscribers may translate into a market for integrated receiver-decoders worth $15-20 billion over 12 years, depending on the accessibility of the Chinese market.

1.2.1.3. Compression

Whether compression techniques become operational will have a decisive effect on the transponder market. High-definition television and direct broadcasting have already been wrongly predicted in the early 1980s to revolutionize satellite markets, but times have changed. Commercial television projects from Argentina to Egypt and from Thailand to Luxemburg now assume that digital compression standards and equipment will have become widely available in the late 1990s. The vast resources devoted to developing these technologies and to starting the mass production of decoders, generally based on the International Standards Organization's MPEG 2 standard, give credence to this assumption. In particular, U.S. direct broadcast operator DirecTv Inc. and several large cable network operators and regional telephone carriers are investing in the requisite manufacturing capability.

1.2.1.4. Localization

A key factor in the development of Asia-Pacific television markets is the growing localization and specialization of programming since about 1993. Until then, satellites had been used mostly by the region's national broadcasters to extend their reach outside major urban areas, and by a few pan-Asian broadcasters, many of them coming from the saturated U.S. cable television market, seeking to blanket Asia with general-interest programming. The region's television industry is now driven by narrowcasting, the distribution of specialty programming to niche markets defined by linguistic basins or interest groups; as a minimum, consumers in the late 1990s will expect to receive news, movie, musical, sports and general entertainment channels in their own language or dialect. This will substantially increase transponder demand. At least one large multichannel package, encompassing about 100 local-language channels, can be expected to operate in each of the region's principal markets; such projects already exist in Australia and Japan, and smaller packages of about 20-60 channels are in preparation in Indonesia, Malaysia, Singapore and South Korea.

While the audience of regional channels such as STAR TV grew rapidly in the early 1990s, these programs faced no substantial competition from the established national networks, which often lived on monopolies and had grown complacent; others such as Time Warner Inc.'s HBO Asia, a subscription movie

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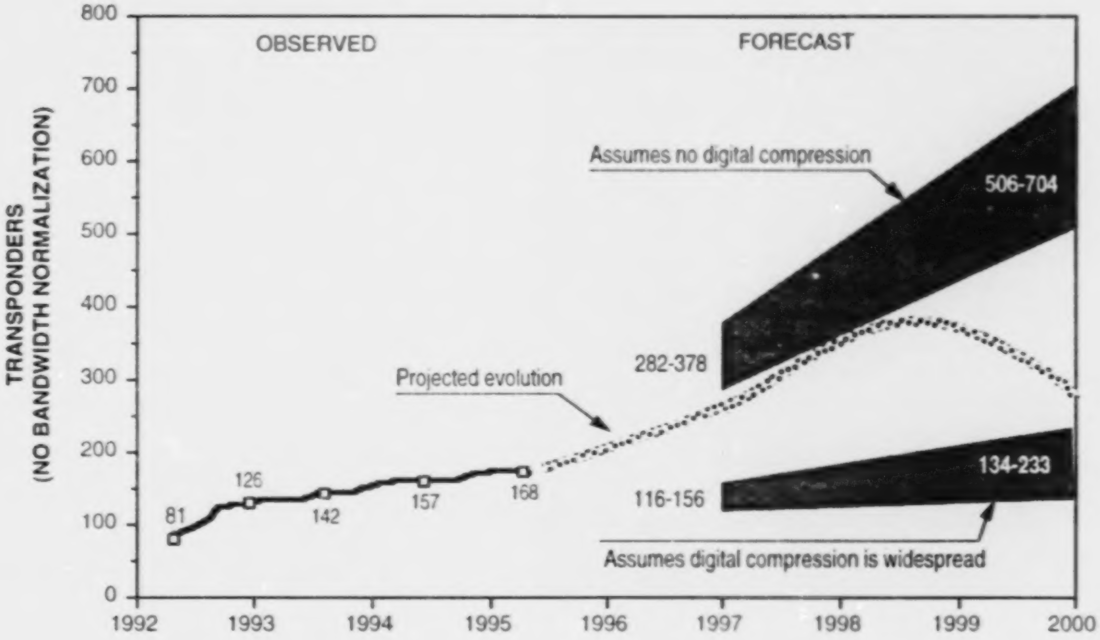
Transponder demand for television distribution in the Asia-Pacific region, 1992-2000



- SOURCE: Euroconsult

channel, successfully targeted elite minorities with high disposable income and sufficient English language fluency, but did not build up a very large audience. Advertisers were the first to point out that Australian, Chinese and Malaysian viewers do not normally seek out the same movies, news or sports, speak different languages, react differently to dubbing or subtitling, live in different time zones and are not familiar with the same brands of toothpaste. The concept of regional channels had in fact already been disproved in Western Europe in the late 1980s. STAR TV was again the first to proclaim localization as its new strategy in 1993, after its acquisition by the News Corp. However, market research in the Asia-Pacific region did not become detailed enough to support such plans until recently. Broadcasters also needed time to locate and negotiate rights with local producers and film libraries; this remains an obstacle to the development of some promising markets such as South Korea, whose small program industry is hard put to fill the vast capacity of the cable networks commissioned in early 1995. Other major markets, including China, Malaysia and Indonesia, remain difficult to penetrate for political reasons, or due to uncontrolled video piracy. China, in particular, has been seen so much as the region's main event by Western broadcasters that smaller markets with better short-term prospects received less attention than they deserved.

1.2.2. Transponder demand

An estimated 1,321 television channels were available throughout the Asia-Pacific region at the end of 1994, including 269 over-the-air UHF or VHF channels and 1,052 cable channels. However, about 900 of the latter are local Chinese programs, whose number is likely to decrease in future years through consolidation and rationalization; the region's two other large cable markets, the Philippines and Taiwan, have about 50 cable channels each. As of April 1995, a total of 165 channels were distributed by satellites, to UHF or VHF retransmitters, cable head-ends and direct reception antennas, filling 168 transponders on 31 satellites.

Based on known projects and the likely evolution of each national market, the region's lineup is projected to grow by 13-23%, to reach 1,493-1,625 channels by 1997, of which 282-378, or about 19-23%, will be accessible to satellite distribution, either to feed cable networks or as part of direct broadcast packages. Based on the known or expected plans of program suppliers with regard to digital signal compression, this would translate into demand for 116-156 transponders, marking a decrease of about 7-30% from the current level of demand.

There is still reason to doubt that digital compression will have an immediate effect on the market: digital integrated receiver-decoders are now just becoming available in large quantities for U.S. direct broadcast programs, and should remain relatively scarce and expensive in the Asia-Pacific market by 1997. Broadcasters may deal with this situation either by deferring their projects or by leasing more transponders. Since niche channels must be amortized over small audiences, the latter solution is probably the least likely. This suggests that transponder demand may be in the range of 200-250 units by 1997.

Television channels will continue to proliferate over the period 1997-2000. The most active markets in that timeframe should be China, with an increasing number of nationwide and regional commercial channels though many small cable programs may disappear; Japan, where two large multichannel packages are already in preparation; and Australia, Thailand and possibly South Korea, as satellite broadcasting becomes more deregulated. The total number of television channels available in the Asia-Pacific region is projected to be in the range of 1,578-1,980 by 2000, including 506-704 accessible to satellite distribution. This would translate into demand for 134-233 transponders if digital compression becomes widespread; an intermediate scenario is more likely, in which actual demand may remain in the same range of 200-250 as projected for 1997.

2. Transponder supply

2.1. Satellite market since 1965

The Asia-Pacific region's importance in the global satellite market has grown steadily, and accelerated at an unprecedented pace from the late 1980s, driven by the sudden development of television broadcasting and the investments committed by Asian nations to the modernization of their telecommunications networks.

As in other satellite markets, three generations are becoming apparent in the Asia-Pacific region. The first generation encompassed 19 satellites ordered from 1965-79 and launched from 1967-85, with a total value of $1,403 million.[4] This first group provided the minimum connectivity required to support international telephony and some of the traffic carried by the principal and most underserved backbone links of island nations such as Indonesia and the Philippines, or the Australian outback. It was dominated by Intelsat, which ordered 14 spacecraft for deployment over the region during that period, but also saw the emergence of its first two domestic systems: Indonesia's Palapa A and Japan's BS-1 direct broadcast satellite.

The second generation ran approximately from 1980-90; the market expanded markedly over that period, with 34 satellites ordered for a total value of $3,945 million and launched over 1983-92. This period saw Australia acquire the region's second domestic system and two competing private systems appear in Japan. Another important development was the launch of Asiasat-1, which brought the concept of a pan-Asian operator and transborder television into Asia.

2.2. Future prospects

2.2.1. Trends to 2005

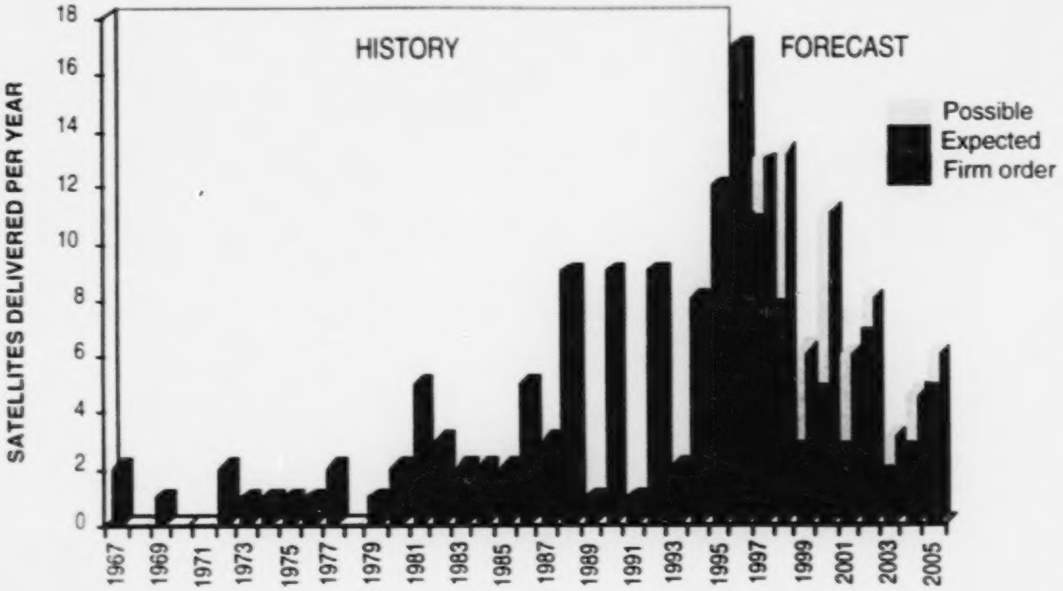
The Asia-Pacific market's third-generation satellites were ordered from about 1991, and should be launched through 2004. Early planning has already begun for the launch of replacement satellites such as the Optus C and Koreasat 2 series from about 2003, which may mark the beginning of a fourth generation.

Altogether, as of June 1995 a total of 86-109 satellites were ordered or forecast to be ordered from 1991-2000 and launched from 1992-2005, with a total estimated value of $7.0-10.15 billion (at 1993 prices), or 1.3-1.9 times as much as that of the first two generations combined. The upper estimate assumes that all existing or planned domestic and regional systems will be replenished, and that one new regional system and three new domestic systems will appear.

Indigenous Asia-Pacific operators, other than Intelsat, Inmarsat and Panamsat, are expected to account for 75-94 satellites, with a combined value of $5.2-9.7 billion, or 74-95% of the total market. Though these operators play a part in the decisions of Intelsat or Inmarsat, they purchase shorter series and require a different marketing approach.

By May 1995, an estimated 41-59% of the projected Asia-Pacific market had already been captured by U.S., European and Russian satellite vendors, with

Asia-Pacific civil geostationary communications satellite market, 1967-2005



Source: Euroconsult

50 satellites worth an estimated $4,142 million ordered from 1991-95, and to be delivered through 1999. These include 39 satellites worth $3,251 million ordered by indigenous Asia-Pacific operators, or 33-62% of that market segment. Five months into 1995, the year was already the industry's best ever, with orders received for eleven satellites worth an estimated $1.34 billion.[5]

This current phase of the market's evolution is driven by several trends which all point to its rapid maturation:

- All Asia-Pacific countries with gross domestic product in excess of $90 billion, except for Brunei Darussalam, have now acquired domestic satellites. No new national markets are likely to emerge within a decade, except possibly under anchor tenancy agreements similar to those already negotiated with foreign operators by low-income countries such as Tonga and Papua New Guinea.

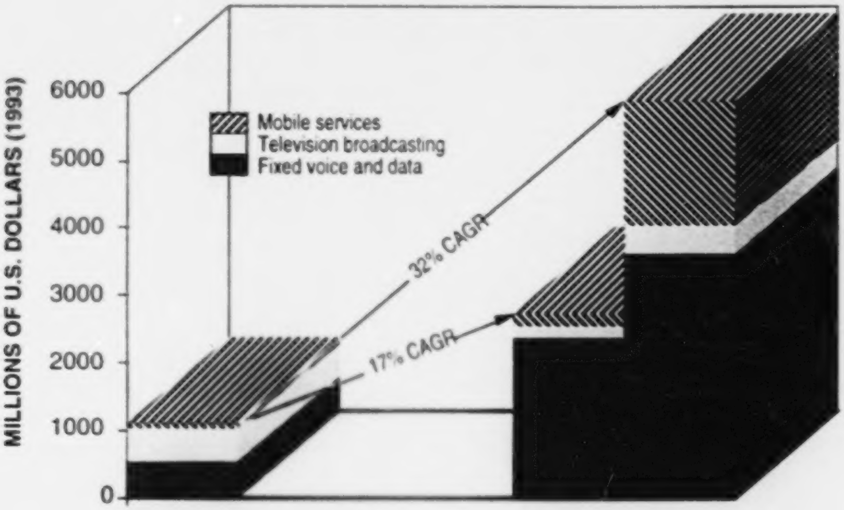
- The regional markets for broadcasting and business services have become healthily competitive. Five major systems (Intelsat, Asiasat, Apstar, Palapa and Panamsat) already provide pan-Asian services from India to Oceania, and will be joined by a number of smaller contenders. Domestic users in Japan, the Philippines and even China also have a choice of satellite carriers; domestic satellite services will be deregulated in Australia in 1997 and in Thailand in 1999, opening two large, high-income markets to competition.

- The needs of most countries for basic telecommunications and television services being satisfied, Asia-Pacific operators are now moving on to specialized services such as mobile and personal communications, digital audio broadcasting and high-power direct broadcasting.

The first trend is adverse to further market growth, since domestic systems will now probably support only a replenishment market. However, the region's replenishment market is already vigorous: out of the 77-100 geostationary satellites to be delivered over 1995-2005, 38-42 will replace spacecraft to be retired from constellations already in operation today, while 39-58 would be new entrants or extensions of existing systems. Japan, in particular, has become entirely a replenishment market, since the licensing of a third private operator is considered an unlikely prospect.

The Asia-Pacific market is thus expected to pause briefly from 1998-2004, as the market absorbs the massive influx of transponder capacity of the mid-1990s, at least assuming that current launch manifests are verified; it is not clear that commercial

Asia-Pacific satellite communications and broadcasting service market (1994-2000)



1994: $1,048-1,125 million
Mobile services: $53-70 million (5-6%)
Broadcasting: $494-513 million (46-47%)
Voice and data services: $501-542 million (48%)

2000: $2,701-5,890 million
Mobile services: $190-1,850 million (7-31%)
Broadcasting: $151-420 million (6-7%)
Voice and data services: $2,360-3,620 million (62-87%)

CAGR: Compound Annual Growth Rate.

SOURCE: Euroconsult.

launch service providers can cope with the high level of demand from Asia-Pacific operators, and it is likely that the peak of 11-17 launches forecast over 1995-97 will actually stretch over a longer period.

The frequency coordination process is not expected to significantly constrain the market. New systems have appeared so rapidly in recent years that some satellites have been launched without completing this process, which has also become extremely complex and time-consuming, creating concern that the geostationary arc may be coming close to saturation over the Asia-Pacific region. A number of technical and procedural remedies exist, however, and, despite some high-profile disputes, there is reason to doubt that orbital crowding will appreciably prejudice Asia-Pacific operators.

Given design lifetimes of 10-13 years for most of the satellites launched from 1988-94 and 13-15 years for most of those to be launched from 1995, the market may be expected to peak again from 2005-2010.

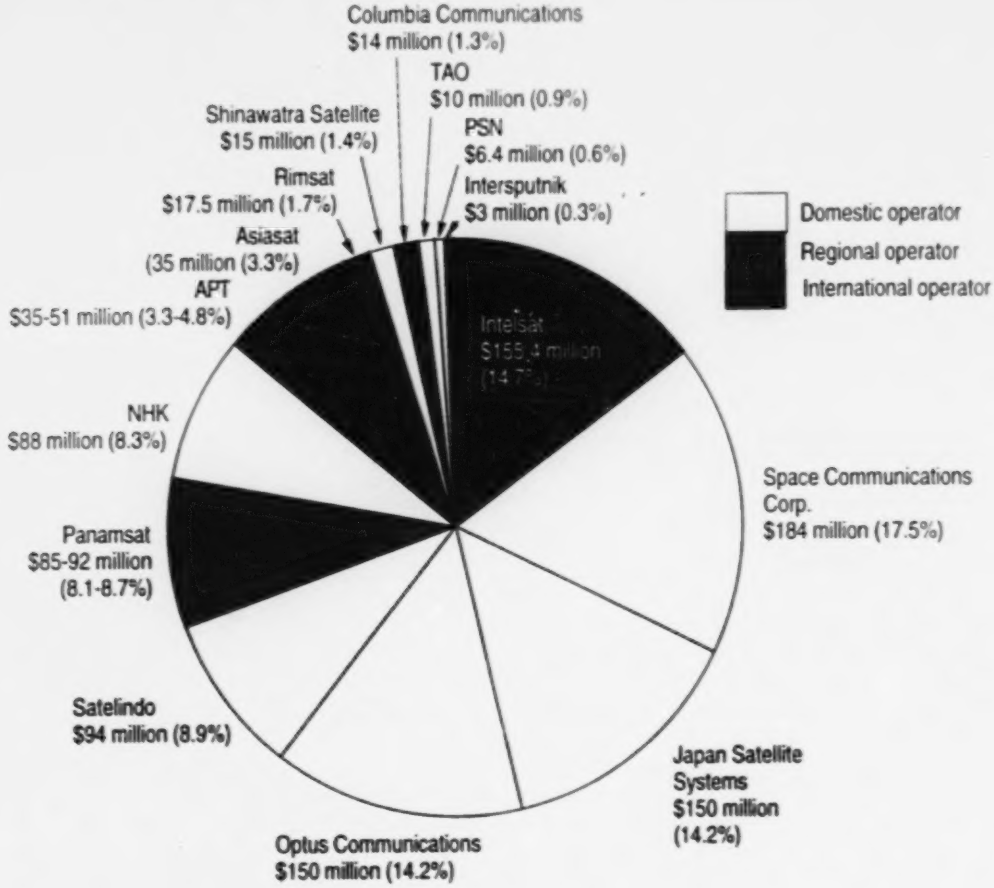
2.3. Transponder leasing market

The Asia-Pacific transponder leasing market is estimated to have generated revenue of about $1.054 billion in 1994 for the sixteen satellite operators which then provided capacity. Intelsat ranked first among these, unsurprisingly since it also possesses over 53% of the region's transponder supply. Space Communications Corp. and Japan Satellite Systems Inc., Japan's two private operators, are believed to rank second and third, largely because of the high price of their Ku-band transponders. The revenue of transponder leasing for fixed services and television broadcasting would increase from about $1 billion in 1994 to $2.5-4 billion by 2000.[6]

2.3.1. Supply-demand equilibrium

The Asia-Pacific transponder leasing market has been increasingly tight since the late 1980s, suggesting that demand was seriously under-estimated by the region's operators in the past decade. By early 1995, all available satellites operate at saturation, or close to it: Indonesia's Palapa B satellites, Rimsat Ltd.'s two Rimsat G satellites, Asiasat-1, Apstar-1, Panamsat Corp.'s PAS-2 and Thailand's Thaicom-1 and 2 are fully leased, while

Transponder leases for fixed services in the Asia-Pacific region: Estimated market shares (1994)



SOURCE: Euroconsult.

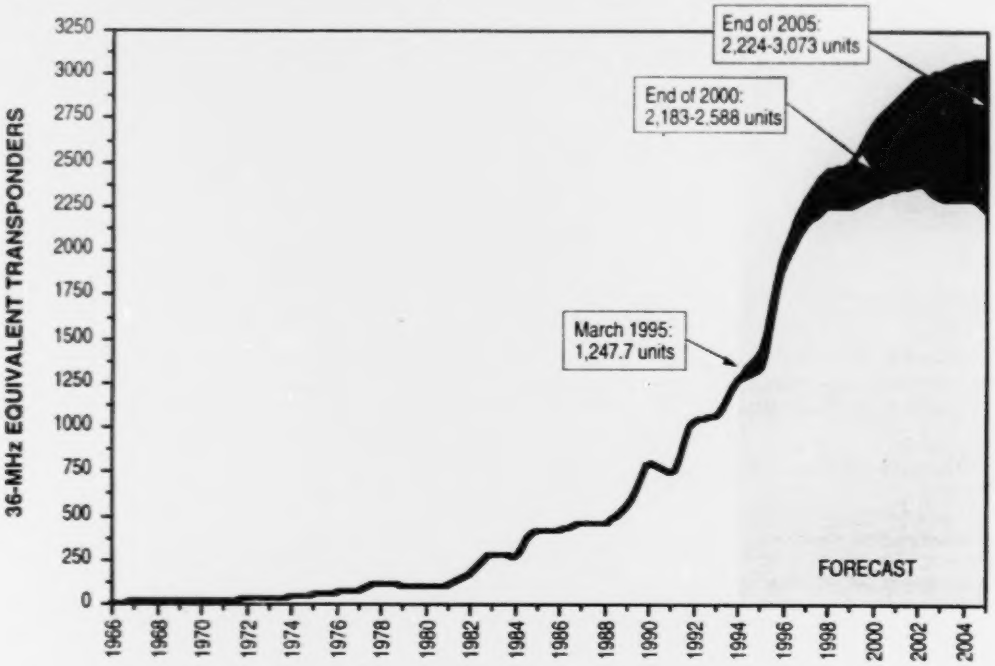
Asiasat-2 and Palapa C1 appear to be 90% full. The only operators which appeared to retain more than 20% unused capacity at the end of 1994 were Columbia Communications Corp., whose business started relatively recently and relies on low-power satellites with less than optimum coverage, and the Australian and Japanese domestic systems, handicapped by high prices, unfavorable regulations and strong terrestrial competitors.

The transponder market will change more in the Asia-Pacific region over the period 1995-98 than it ever did in any other part of the world within such a short timeframe. Transponder capacity is forecast to grow from the 1,241 36-MHz units available as of March 1995 to 2,183-2,588 at the end of 2000, corresponding to a compound annual growth rate of 11.9-15.8% over six years.[7] The Asia-Pacific region would have access in 2000 to approximately 37-38% of the world's total transponder population, which is then projected to stand at 5,742-6,997 units.

The launches scheduled over 1995-97 will add sufficient transponder capacity to largely resorb the current shortage. By 1997, transponder supply is forecast to exceed demand by a margin of 26-32%. This, however, is close to the 30% margin which U.S. commercial satellite operators maintained throughout the 1980s; some of this margin will be used by transient applications such as satellite newsgathering. The market will generally remain vulnerable to launch failures, and shortages may persist in some markets.

Moreover, demand will continue to develop at a rapid pace, more than doubling over 1993-2000. The market will have returned to a very tight margin by 2000. Users may cope with this situation by migrating

Transponder capacity over the Asia-Pacific region (1966-2005)



SOURCE: Euroconsult.

Transponder supply and demand in the Asia-Pacific market (1993-2000)

Year	36-MHz equivalent transponders				
	Voice and data	Television	Total demand	Supply	Margin
1993	850^e	142	992	1,005	+13^e
1997^e	1,300	200-250	1,500-1,550	2,101-2,208	+551 to +708
2000^e	2,100	200-250	2,300-2,350	2,183-2,588	-167 to +288

(e) Estimate.

SOURCE: Euroconsult.

more toward terrestrial carriers or using more efficient digital compression techniques, or additional transponder capacity may be put in place. However, maintaining a capacity margin of 30% in 2000 would require a transponder population of 3,285-3,357 units. This is 769-1,102 more than operators are expected to provide by 2000, and, since commercial satellites in the Asia-Pacific region now carry an average of 20-25 transponders, would require the launch of another 30-55 spacecraft over the next five years. It is doubtful that so many satellites could be financed, coordinated, built and launched over that short period in addition to those already on order or forecast to be ordered.

2.3.2. Transponder pricing

Another sign of tension in the market in recent years has been a slow increase in transponder rates. Although the tariff structure of transponder leases is generally neither simple nor published, anecdotal evidence suggests that the average price of a C-band transponder in the Asia-Pacific region increased from about $1 million per year to about $1.6 million in 1994. This level of pricing is similar to that typically quoted in the Middle Eastern market, and intermediate between the $750,000-1 million typically quoted by commercial U.S. operators and the $2-3 million quoted for Western European domestic satellites. Ku-band transponders have consistently been 2.5-3 times more expensive than C-band capacity, though their relative scarcity makes average prices less significant.

The price of C-band transponders is expected to be forced down in the short term, possibly back to the $1-million level. The forces which back this trend include the rapid increase of supply, deregulation, and market fragmentation. As supply becomes more fragmented, prices will be subject to greater competitive pressure: from 53.5% in March 1995, Intelsat's share of the transponder population accessible to Asia-Pacific countries will drop to about 31% by 2000, while the total number of suppliers should increase from 17 to 21-30. Domestic and regional suppliers are also becoming increasingly indistinguishable. Except for the South Korean and Australian systems, all of the satellites ordered by domestic operators in the Asia-Pacific region have regional coverage, either to support their country's international telecommunications or to give its television channels access to other markets. For instance, Japanese satellites, which used to be subject to rules strictly limiting signal overspill into neighboring countries, as well as the Measat and Thaicom systems of Malaysia and Thailand, will provide dedicated beams centered on India, while some of India's Insat 2 domestic systems are being modified to extend their reach as far east as Australia. Finally, digital compression also could make the transponder market more competitive, by allowing broadcasters to shop around for fractional capacity instead of full transponders.

It is not clear that this trend toward lower C-band transponder rates will prevail in the longer term against the rapid increase of the cost and capabilities of satellites. In addition, most of the region's operators are just commissioning expensive spacecraft and will probably lose money over their first 2-3 years of operation, through 1997-2001, leaving little margin for price reductions; Aussat Pty. Ltd., the Australian operator, remained consistently in the red until it became Optus and ceased to report its revenue in 1992. These factors and the better adaptation of supply to demand make it unlikely that C-band transponders will lease for less than $1-1.5 million per year in the period 2000-2005.

The price of Ku-band transponders will probably come down slightly if demand for this frequency band remains at its present low level. Moreover, the rates charged for Ku-band capacity in Australia, South Korea, Thailand and Malaysia are probably not representative of future levels, since these markets are controlled by monopolistic operators. Deregulation may lead the price of Ku-band transponders to settle at the level of 1.5-2 times the average price of C-band transponders, as is now the case in the U.S. market, which would correspond to about $1.5-3 million per year.

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[1] The Asia-Pacific region is defined here as encompassing all countries East of Bangladesh and West of Hawaii, including the territories of Eastern Siberia.

[2] Euroconsult estimate based on revenue comparisons [*Economic Impact of Competing Space Segment*, Report to the Commission of the European Communities, Euroconsult, Paris, Mar. 1993, p.2.]

[3] A distinction must be made between the number of satellite antennas installed and the number of "satellite homes", since dozens of households may share a single dish set up at the top of an apartment block. Households are taken as the most relevant unit in assessing the prospects of satellite broadcasting, since they generate the revenue with which broadcasters pay for their transponders.

[4] All dollar figures are adjusted to the economic conditions of 1993, based on deflators indexed on the U.S. gross domestic product.

[5] The last satellite included in this count is Garuda, for which Lockheed-Martin Corp. announced contract negotiations on May 19, 1995. Other awards were then considered imminent.

[6] The lower estimate assumes that 134 transponders will be leased for television broadcasting and 2,100 transponders will be leased for voice and data applications, including 25% of Ku-band transponders; C-band and Ku-band transponders are assumed to be priced respectively at $1 million per year and $1.5 million per year. The higher estimate assumes that the same number of transponders will be leased for voice and data applications, but that 233 transponders will be leased for broadcasting, that C-band and Ku-band transponders will be priced respectively at $1.5 million and $3 million per year, and that the higher price of Ku-band capacity will limit their share of the market to only 15%. Higher transponder prices may possibly result in lower transponder demand and reduce the market's value to some intermediate figure.

[7] These estimates include all C-band, Ku-band, Ka-band and S-band (when used for fixed or broadcast service) transponders operating on the domestic satellites of Asia-Pacific countries, the satellites of international and regional operators such as Intelsat, Panamsat Corp. and Columbia Communications Corp. accessible in Asia-Pacific countries, and India's Insat domestic satellites, whose coverage includes most of the Asia-Pacific region. The footprints of many of these satellites, such as the Intelsat, Asiasat, Panamsat, Apstar and Thaicom systems, may extend significantly beyond the Asia-Pacific region as defined here; the entire capacity of these satellites is then counted as available within the Asia-Pacific region. This may result in a slight over-estimate. Experimental, non-geostationary and military satellites are not taken into account.

Roles of Satellite Communication in Global Information Infrastructure(GII)

Dr.Seon J. Chung

Vice President, Electronics and Telecommunications Research Institute(ETRI)
Taejeon, Korea.

ABSTRACT

Global Information Infrastructure(GII) will be an information superway consisting of the terrestrial broadband networks and satellite communication links. The important feature of the future telecommunication services by GII will include personal mobile service and high speed multimedia information with broad availability at any time and anywhere to anybody. There are numerous issues which must be worked out in order to construct GII with the wireline and wireless communication links.

1. Information Superway

After several years of consensus building dialogue between the optical fiber and the satellite sides, experts now agree that the Global Information Infrastructure(GII) should be an integrated structure of Information "Superhighway" with Information "Superskyway". This paper describes a prospective view on the physical base of GII in the side of telecommunication service by satellites, "Information Superskyway". The physical base of GII will be a global information superway.

In early eighties, the mating of the information processing by computer and the communication by telephone network gave birth to the Integrated Services Digital Network (ISDN), in which the transmission lines of optical fiber and the digital computer have been merged into the long existed plain telephone network. The integrated services of sound, text, data, graphics and video information is now defined as "multimedia" and will become the major menu for future telecommunication service in the GII. On the other hand, the wireless communication so far has been confined in the limited usage due to the high cost, constraint of spectrum availability, security and lack of standardization . Wireless communication on the ground is recently being highlighted by cellular mobile communication and PCS. In the satellite communications sector, only long distance trunking was commercially justified until early 80's. Today, multiple access VSATs, SCPC/DAMA, and digital multichannel DBS services by GEO satellites for domestic and international market are economically well accepted.

Within a few years, the voice, data and multimedia services via LEO satellites looks like a promising new service. Once more we are going to witness another revolution in the telecommunications. This time, the revolution may transform every sector of our daily life into what is called information age. The physical apparatus on which the information age will be founded must be information superway with much more advanced capabilities than we are familiar with. The information superway as the base of GII which we are expecting after 20 or 30 years will be a telecommunication network system which has features and capabilities to:

1) collect, store, deliver and distribute information,
2) exchange information interactively,
3) serve as information source,
4) play with like recreation toy,
5) monitor and control the public or private facilities.

GII is not only a information transporter or message exchanger, it may be a facility which is supposed to provide the role of interactive information source for electronic readers, pharmacist, housewives, judges, doctors and school instructors. They retrieve well prepared stories, prescriptions, shopping guides, rulings, diagnosis and curriculums from well placed information archives; role of transporting and delivering of massive merchandise of multimedia information to customers within the interactively near real-time; role of recreation device for video-on-demanders, TV viewers, video game players, karaoke goers, M-TV dancers; and finally role of monitoring and remote controller via telecommanding for utility boxes, status watchers, facility switches, etc.

Global Information Infrastructure is supposed to be a integrated global facility which produces, processes, stores and distributes information to users. Considering its complexity and multidiciplinary nature, this futuristic information superway is conveniently called a "Infrastructure". In order to construct this infrastructure, numerous elements are to be mobilized globally. Large investment for long period of time, promotive government policies, user adaptation for new services and the new technology development are required.

GII concept is already generating large scale of reorganization in telecommunication and information industry. Computer and communication, wireless and wireline networks, broadcasting and telecommunication services, CATV and telephone networks are moving toward being merged, combined or connected each other for global, personal, multimedia telecommunication service. In parallel with physical merges, the related business and industry are also following the track. The evolution of telecommunication service is shown Figure 1.

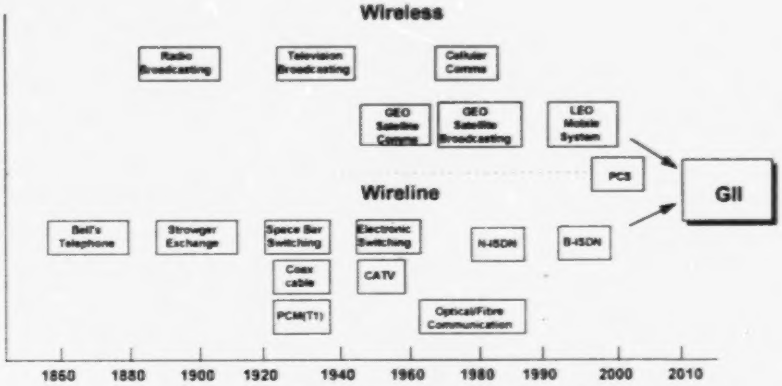

Wireless
Radio Broadcasting
Television Broadcasting
Cellular Comms
GEO Satellite Comms
GEO Satellite Broadcasting
LEO Mobile System
PCS
GII
Wireline
Bell's Telephone
Strowger Exchange
Space Bar Switching
Electronic Switching
N-ISDN
B-ISDN
Coax cable
CATV
PCM(T1)
Optical/Fibre Communication
1860
1880
1900
1920
1940
1960
1980
1990
2000
2010

Figure 1. Evolution of Telecommunication Service

2. Telecommunication Services Expected from GII.

For last three decades, evolution of the service features of telecommunication has been impressive. For next 30 years, it is easy to predict another revolution. When completed, GII is expected to provide service features which can be categorized as;

"ANY KIND" of service" at "ANY PLACE" at "ANY TIME " to "ANY ONE"

In an ideal GII, we expect that "ANY KIND" of multimedia information and telecommunication services will be available at "ANY WHERE", at "ANYTIME" to "ANY ONE ". This 4 "ANY" features are achievable only by combined network of wireline and wireless transmission.

- Any kind of information service ;
  voice, sound, text, facsimile, data, graphics and video, and furthermore, the combination of these information services, so called "multimedia" service, are supposed to be offered interactively in near real time bases in point-to-point or point-to-multipoint mode by GII.

- Anywhere, Anytime ;
  As long as we live, we look for information all the time wherever we are. The terrestrial wireline network service is limited to the reach of the fixed terminals such as telephone units, multimedia terminals, fax units, workstations or public

telephone booths. In wireless communication, carrying a phone set or multimedia terminal with us to every place we go, at home or outdoors, we can call or receive information which we want regardless where we are, i.e., in the bus, airplane, car, ships, yachts, train, bathroom, office desk or on the street. The exploding demand in mobile communication service in recent years clearly indicates that "anywhere" and "anytime" feature is the primary requirement of telecommunication service in the future information network. The "anywhere" feature is unique to wireless service. Mobile communication service by terrestrial cellular network provides local "anywhere" feature, while mobile service by GEO/LEO satellites will provide global "anywhere" feature.

It is certain that the cost improvement of mobile service will bring cost competitiveness against wireline PSTN and the strong growth will continue for the time to come. Then, the LEO mobile services which is scheduled to be launched from 1998 will coexist for some time with terrestrial cellular service until it takes over the lead.

- Anyone ;
  If the telecommunication service is an essence for the continuous contribution to balanced development of this world, it should be available to any body. What "anyone" feature of telecommunication service implies is the equal opportunity for information access and, at the same time, the cost that anyone can afford to pay for it. This essential service should be available to everybody from Eskimos to jungle tribes if it is supposed to be global. With the technology improvements, the equipment and system cost have come down considerably, but the telecommunication service is still not for everybody in the world. Even though satellite beam coverage is more global than telephone network, unless the satellite communication improves its cost further, the "anywhere" feature of GII may not be integrated with "anyone" feature.

3. Functional Requirements of GII

These service features mentioned above may be implemented at high cost and long process of realization of system features in GII. Some of the features are listed in the following;

- Interactiveness
  This feature is essential for real time interface between GII and service users such as VOD, pay-per-view, game players, electronic library, etc.

- Open Interface with Information Sources
  Information input to GII must be universal to any type of information source and format of input signals and devices.

- System Capacity
  Multimedia, interactive, high speed and intelligence in the GII implies large throughput and capacity of storage subsystem, transmission links.

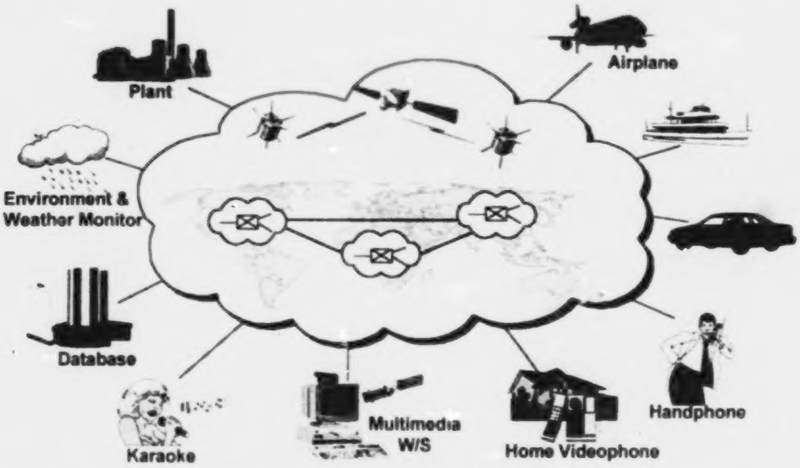


Figure 2. Global Information Infrastructure

- System Intelligence
  Large and complex system must have self management capability to maintain reliable operational conditions of the system and sustain system performance.

- Open System Interconnection
  Interconnectivity and interoperability among devices, user terminals, networks, superways and National Information Infrastructures(NIIs) to construct a GII is the key functional requirement among others. This feature is not only a technical requirement but also international cooperation issue.

- Global Management
  Many NIIs are to be connected together to build GII. For this goal, global roaming, numbering and billing scheme must be devised according to the new networking concept.

Figure 2 shows the Global Information Infrastructure.

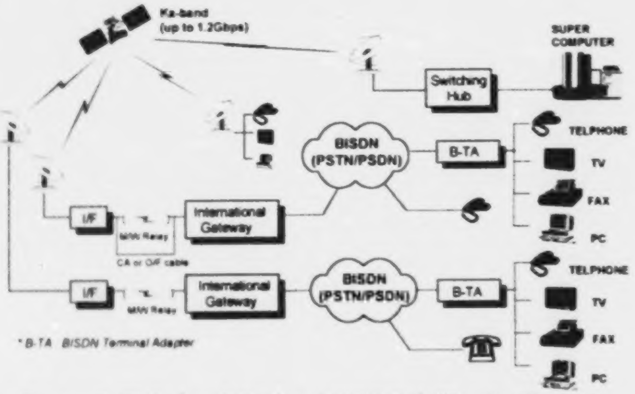
4. Characteristics of Satellite Communication in GII

The satellite communication link has been favored in the hostile environment for the transcontinental and transoceanic long distance trunk for transmission, for which wireline is sometimes not economically justified or possible to install at all. Now we are witnessing a space race toward geosynchronous and polar orbits by communication satellites. More and more households or apartment buildings nowadays install parabolic antenna for DBS program reception. The major service feature "anywhere" expected from GII can be provided uniquely from Information Superskyway segment. Major characteristics of the Information Superskyway segment are categorized as following :

- Mobile Terminal Service
  Global and simultaneous nature of the audio or video communication by satellite allows information service feature ANYWHERE in its foot print coverage. While the terrestrial cellular phone subscribers are growing so fast, the voice and video service by satellite mobile telecommunication network may soon take competitive position against terrestrial mobile service in early year 2000.

- Simulcast
  Unique feature of "broadcasting" by radio communication is the key function for "Anywhere" feature of GII. Direct Broadcasting by satellite has gained its economic momentum by digital compression technique. Analog transponders serving one analog video channel now can accommodate more than 6 to 8 digital channels improving economic efficiency several times.

- Survivability
  Information Superskyway is less volunerable than Information Superhighway to the terrestrial disasters like earthquake, flood, fire, and terrorist attack, etc. Alternative path and backup for the enhancing the reliability of terrestrial system in GII in case of terrestrial disaster is one of the roles of satellite links.



*B-TA BISDN Terminal Adapter

Figure 3. Global and Regional GEO Satellites for Trunking

- Rapid Deployment/Easy Reconfiguration
  Satellite links are easily installed by frequency assignment in the transponder and pulling the cable to the ground tranceivers from user terminals. Using software user ID, satellite links can be easily reconfigured from one user point to another on the ground. Quick installation of earth terminals for use for the limited time is one of the unique features of satellite communication.

5. Models of satellite and terrestrial network interface in GII

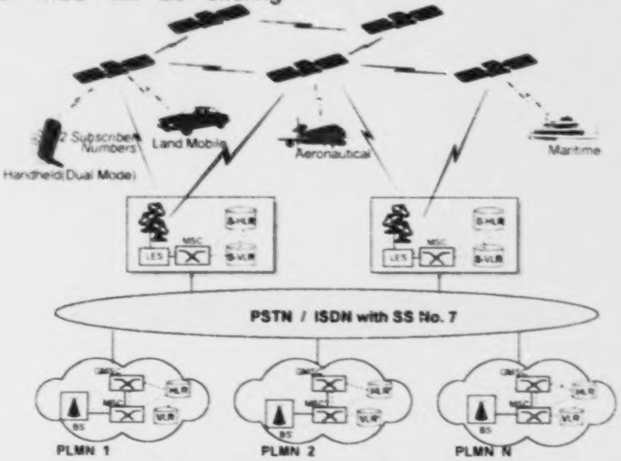
By the time when GII is forming its shape, elements of terrestrial network will consist of PSTN, PSDN, Cellular Radio Network, Terrestrial Broadcasting Network, CATV. On the other hand, in space, GEO FSS, GEO BSS, GEO MSS, LEO and ICO global network for MSS will be offering domestic, regional and global service. These two segment may be connected each other in several different ways. Examples may be categorized into 6 models:

1) Long Span Trunking :

Trunking by satellite links has long demonstrated the economic advantages over submarine or terrestrial cable for long span links. This application of the satellite links will be expanded to global, regional and domestic trunking between gateways or teleports. (Figure 3)

2) Bypass Network :

Direct competition with terrestrial telephone network by wideband transponders will be realized. Spaceway, Teledesic, AceS, ACS are currently proposed examples.(Figure 4)


2 Subscriber Numbers
Land Mobile
Aeronautical
Maritime
Handheld(Dual Mode)
S-HLR
MSC
LES
S-VLR
S-HLR
MSC
LES
S-VLR
PSTN / ISDN with SS No. 7
GMSC
HLR
MSC
BS
VLR
PLMN 1
GMSC
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GMSC
HLR
MSC
BS
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PLMN N

Figure 4. Satellite Links Bypassing Terrestrial Network

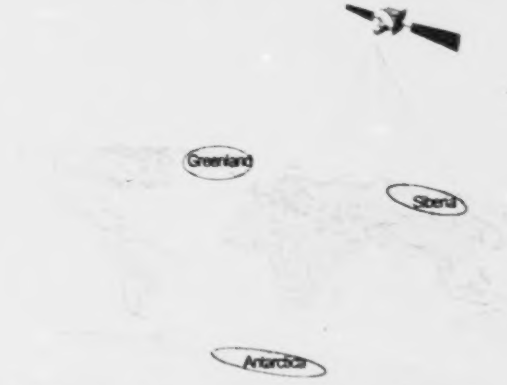

Greenland
Siberia
Antarctica

Figure 5. Dedicated Beam for Remotely Isolated Island or Continents

3) Territory sharing Network :

Vast wild continents with thin inhabitants like Alaska, Central Asia, India, Africa, Siberia, and archipelagos such as Polynesian Islands, Philippines, Indonesia will be almost dominantly served by satellite communication networks without competing with terrestrial network via mutual interconnection via trunk gateway. (Figure 5)

4) Complimentary Service Network :

Some of the telecommunication services by satellite are not implementable by terrestrial network and exclusively unique to satellite. Mobile or half-fixed terminal services by either GEO or LEO may be able to coexist with terrestrial network in a mixed configuration without service market competition. (Figure 6)

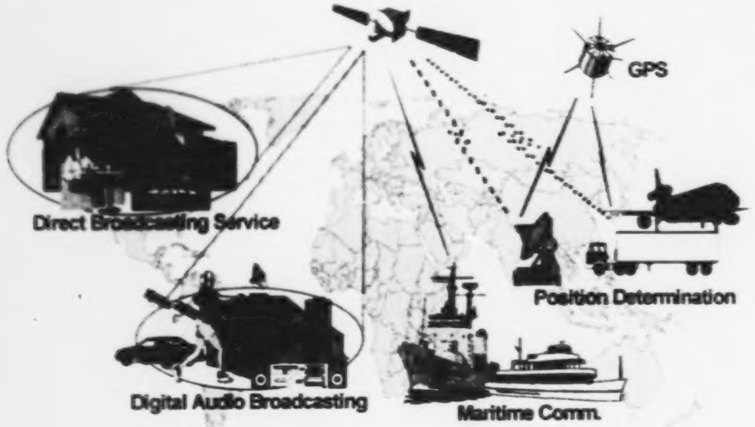

GPS
Direct Broadcasting Service
Position Determination
Digital Audio Broadcasting
Maritime Comm.

Figure 6. Dedicated Satellite for Unique Service Type

5) Subscriber Access and Distribution Network :

Star configured VSAT networks for data base access or DAMA/SCPC networks for voice service may be a economical access net for remote rural and island subscribers to terrestrial local switches or central DB. (Figure 7, 8)

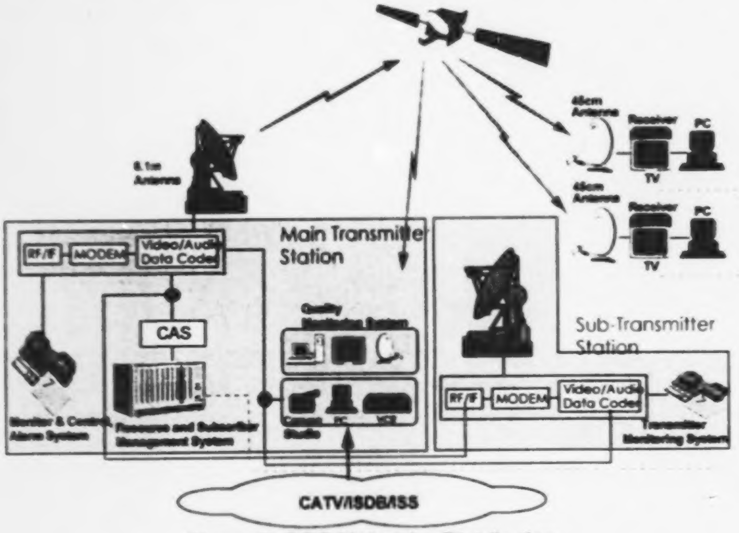

6.1m Antenna
45cm Antenna
Receiver
PC
TV
45cm Antenna
Receiver
PC
TV
Main Transmitter Station
RF/IF
MODEM
Video/Audio Data Codec
CAS
Quality Monitoring System
Monitor & Control Alarm System
Resource and Subscriber Management System
Camera Studio
PC
VCR
Sub-Transmitter Station
RF/IF
MODEM
Video/Audio Data Codec
Transmitter Monitoring System
CATV/ISDB/ISS

Figure 7. DBS Network - Distribution

BEST COPY AVAILABLE

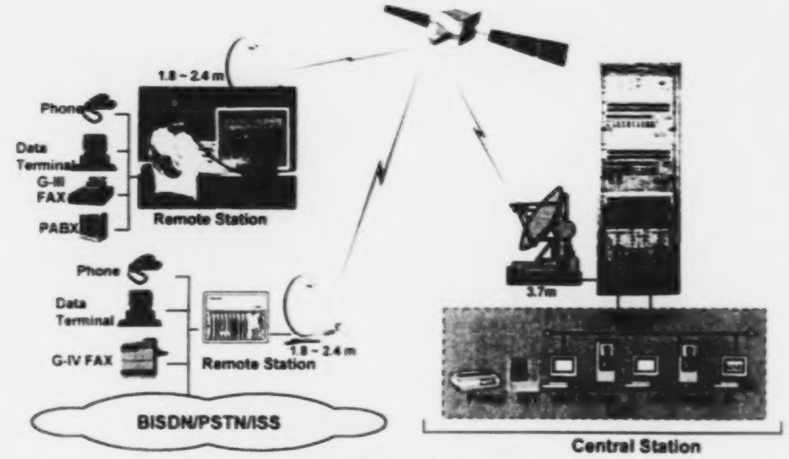

1.8 - 2.4 m
Phone
Data Terminal
G-III FAX
PABX
Remote Station
Phone
Data Terminal
G-IV FAX
1.8 - 2.4 m
Remote Station
3.7m
BISDN/PSTN/ISS
Central Station

Figure 8. DAMA/SCPC Network - Access

6) Independent Satellite Network :

As the terrestrial VAN, satellite VAN may be popular among big business groups for global corporate communication. This satellite may be privately owned and operated as independent and isolated network. (Figure 9)

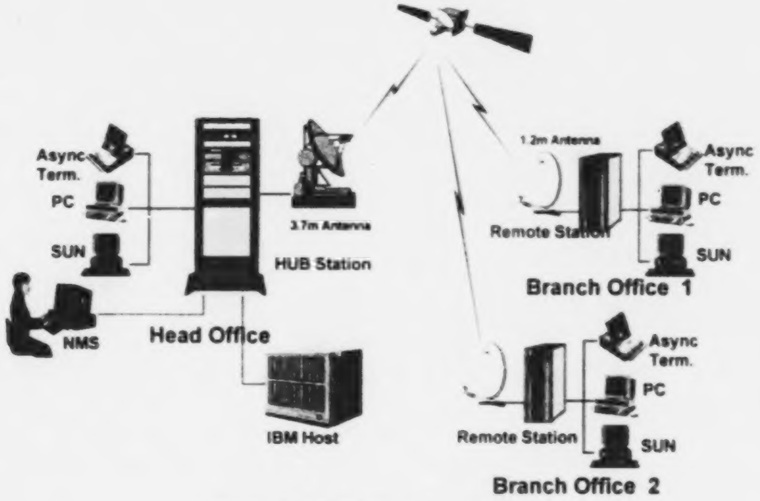

Async Term.
PC
SUN
NMS
Head Office
3.7m Antenna
HUB Station
IBM Host
1.2m Antenna
Remote Station
Async Term.
PC
SUN
Branch Office 1
Async Term.
PC
Remote Station
SUN
Branch Office 2

Figure 9. VSAT Corporate Network

6. Issues in integrating Information Superskyway with Information Superhighway

- Regulation

  Redraw or break the boundary line between wireline and wireless services and network operation so that both network systems and service operations may be combined together, the business commodity must be reoriented to services, not the transmission media. On the other hand, the efficient planning and regulation of the spectrum assignment is essential in maintaining quality of services by radio links.

- Development of gateways for connectivity with superhighway

  Interface between satellite links and PSTN is realized through gateway earth stations of satellite links. GEO and LEO satellite gateway need to be equipped with OSI Interface capabilities for any networks protocols.

- On board communications processing
  In order for wide band GEO/ LEO satellites to interface with intelligent terrestrial B-ISDN, payload should be equipped with on board communications processing function such as switching, mux/demux, message reformatting and control, etc.

- Ground system standardization
  Globalization of satellite communication network requires the global system standards in network functions of ground equipment and must smoothly interface with terrestrial network elements.

- Spectrum resource expansion
  Network capacity of satellite links should be expanded by technologies in frequency reuse or bandwidth expansion. Unlike terrestrial network, satellite links must be well managed according to assigned spectrums in order to avoid interferences.

- International coordination for Orbit & Spectrum Allocation
  Economical competiveness of satellite communication will be the best solution for promotion of satellite communication in the GII. There seems to be much more potential for technology breakthrough in satellite communication in near future than the terrestrial communication.

7. Conclusion

The information service features required in the information age are well symbolized in Global Information Infrastructure by 4 prefixes; "any services, anytime, anywhere by anyone". These features may be globally realized only by combining satellite communication systems with terrestrial communication system. Information Superskyway, which will provide global mobile telecommunication service, multicast capability with global coverage at improving service cost, will become the primary element of the Global information Infrastructure.

Dr. S.J. Chung obtained his B.S. EE from Seoul National University, Korea in 1964 and earned his Ph.D. in Space Communication from the Pennsylvania State University in 1976. He worked in Lockheed Electronics and Ford Aerospace in Houston for Space shuttle project form 1976 to 1982.

He joined ETRI in 1983 and managed Korean ISDN Project until he became Vice President for Satellite Communication Division in 1988. He is also serving as President of Asia-Pacific Satellite Communication Council(APSCC), a regional cooperation organization for Asia-Pacific.

Enhancing Mexico's Information Infrastructure

Kathleen Ann Griffith
Informatica
Washington, DC
United States

1. ABSTRACT

Mexico's information infrastructure has undergone significant improvement since the privatization of Telmex. Infrastructure development will continue, in spite of the on-going economic crisis, in response to the opening of competition in the lucrative long-distance market. Several companies have already acquired concessions for public networks and have committed to new infrastructure investments. Incentives to enhance the local loop through cellular and satellite communications are being implemented, as well. In addition, Direct-to-Home (DTH) satellite TV is expected to provide multimedia access in Latin America later this year.

2. IMPROVEMENTS SINCE PRIVATIZATION

During the last five years since privatization, Telefonos de Mexico (Telmex) significantly improved telecommunications infrastructure and service in Mexico. To meet the requirements of the concession, Telmex' telephone service attained several goals including: basic services in all communities with more than 500 inhabitants; automatic switching services for all communities with more than 5000 inhabitants; and 2 public pay telephones for each 1000 persons. In addition, automatic switching must be provided in all communities with at least 100 requests and improvements must be achieved in the quality of service, especially regarding reported failures, by this year.

By the end of 1995, Telmex had installed almost 9 million lines, up from 4.5 million in 1990. Telephone density has reached 9.6 lines per 100 inhabitants, up from 6.5 in 1990. The wait for a new line has dropped to less than three months, from three years before privatization. The number of pay phones has tripled, to approximately 240,000, with at least one in every location with more than 500 inhabitants, excluding the area of conflict in Chiapas. Telmex' capital spending during these past five years approached $12 billion, including $1.3 billion for telephone equipment, $2.7 billion for transmission equipment, $3.9 billion for switches and power equipment, and $3.7 billion for outside plant.

With the intent to compete in global multimedia services, Telmex purchased 49% of Empresas Cablevision, a subsidiary of Grupo Televisa, in 1995. Cablevision offers transmission of point-to-point TV and had 210,000 subscribers for its 24-channel basic service by mid-1995. It offers 7 premium channels, as well. Cablevision is only required to give access to other telephone companies if its cable network (more than 7000 kilometers) is open to telephone service for Telmex.

The Telmex partnership, which already included SBC Communications and France Telecom, formed a joint venture with Sprint to enhance its value added services, such as call waiting and calling cards, and its international network. Now Telmex has an option to align with and benefit from the Sprint/Deutsche Telekom/ France Telecom/Call-Net "Phoenix Project". Such alliances will ensure Telmex' role as a global player, offering seamless cross-border products and services to corporate accounts and other lucrative markets.

3. CONCESSIONS FOR PUBLIC NETWORKS

Mexico's Secretary of Communications and Transportation (STC) has granted several concessions to joint ventures intending to compete in the long-distance telephone market. The market will open up by January 1997. To promote competition and rapidly develop domestic infrastructure, SCT determined that there will be no concession fees and long-distance companies will be free to charge whatever they choose. At least $5 billion is expected to be invested over the next five years by the new competitors in this market.

Iusatel, Avantel, Marcatel, and Investcom were among the first concessions granted. Other players

157

in this market will include US-Mexico joint ventures between AT&T and Grupo Alfa, an industrial conglomerate with major steel interests; GTE International Communications and Bancomer, a powerful Mexican bank, and Valores Industriales (Visa), a Mexican holding company; and MFS Communications of Omaha, Nebraska with Megacable, a Mexican cable television operator based in Los Mochis, Sinaloa.

Iusatel is the joint venture established between Bell Atlantic and Grupo Iusa, a powerful Mexican holding company with wide interests. In particular, Iusacell is the second largest cellular operator in Mexico after Telcel, a Telmex subsidiary. Iusacell's franchises cover more than 70% of the population and it holds a nationwide 450 Mhz license for unspecified services. Iusacell leases fiber optic capacity from the Federal Electricity Commission (CFE). Bell Atlantic owns 42% of Iusacell.

Avantel merges MCI with Banacci, Mexico's largest financial group. Avantel is 55% owned by Banamex, Banacci's commercial bank. Avantel expects to have much of the infrastructure in place by 1997, and a total investment of $1.8 billion in the new network by 2000. During 1995-1996 Avantel is spending $600 million on the first stage of 4,800 kilometers of fiber optic cable linking Mexico City, Monterrey, and Guadalajara.

Marcatel is a joint venture between Mexico's Radio Beep, IXC Communications and Westel of the US, and Teleglobe of Canada . Investcom is a joint venture between Nextel and Grupo Tricom, a steel company based in San Luis Potosi, that plans to invest $1.337 billion.

Revenue of $4 billion a year, projected to grow 15% to 20% annually, easily motivates foreign investors in the long-distance telephone market. Yet, the local loop in Mexico does not have such inherent incentives. Thus, investment is being sought through policy incentives for cellular and trunking licenses to install rural public telephones under the footprint of coverage. SCT will pay for a percentage of the hardware under this program. SCT will be defining the policy for PCS during the 1st semester of 1996, which may also provide new incentives, and plans are underway for more rural telephony applications for the satellite system.

4. SATELLITE PRIVATIZATION

Under the provisions of Mexico's 1995 telecom law, the national satellite will be privatized this year. The terms of privatization are still under review but will provide for more efficient utilization and management of the satellite network, space segment, and value-added services. Assets for privatization include: Morelos II, Solidaridad I & II, 7 orbital slots for Direct-To-Home (DTH), transmit/receive earth stations in Mexico, landing rights in Latin America, interconnection agreements in the US, LEOS & PCS, and Ka-band. Market value for the package of three satellites and 7 orbital slots for DTH has been evaluated by one consultant as ranging from $908 million to $1.865 billion. Revenue from the three satellites reached $115.4 million in 1994.

The Solidaridad Satellites each have 18 transponders in band C, 16 in Ku, 2 in L for mobile telephony. C will be used for television, voice and data; Ku for digital data networks and DTH. Band L has been introduced in Mexico for the first time and is expected to ultimately have 50,000 mobile users and 20,000 stationary users.

Telecomm, the government agency responsible for the satellite system, also controls other services such as telegraph, telex, and wire transfers. Under privatization, these non-satellite services will likely be linked to the postal service, similar to the European model. In 1994, over 5 million telegrams were sent and the number of wire transfers increased to contribute 25.6% of revenues for Telecomm. Currently, 90% of the revenue for the telegraph service is from money wire transfer. Wire transfers are important for half of Mexico's population still living in poverty, who frequently depend on income from migrant or illegal Mexican workers in the US.

5. DIRECT-TO-HOME (DTH)

DTH Satellite TV is the much hyped multimedia technology being introduced throughout Latin America this year. New compression technology allows DTH to offer many more channels of video programming, enhanced data delivery services, and ultimately, interactive options. Specifically, DTH will provide hundreds of superior quality TV signals with high clarity images and compact disc quality sound. Mexico has three competitors vying for a position in the DTH market. Yet, there are several systems which still must be in place including: satellite access, hops or control centers, distribution and activation of terminals, and programming. Given the prevalence of pirating in Mexico, security and billing will remain as challenges for service providers.

Hughes Communications has joint ventured with Mexico's Multivision and others in the region to provide DTH service through **Galaxy Latin America**. Although Hughes has enormous advantages in technology, it does not currently have landing rights in Mexico. Thus, Hughes has an interest in acquiring the Solidaridad Satellite System. An international agreement for reciprocity with the US on landing rights may also change Hughes' status. Galaxy plans to offer 72 channels of programming on a Spanish language beam and 72 channels of programming on a Portuguese language beam.

Mexico's Spanish language media conglomerate, Televisa, has joint ventured with News Corporation and TCI2 and Brazil's Globo for a special agreement with PanAmSat to provide wide DTH programming options. Although initially Televisa and PanAmSat were going to provide DTH services through **Galavision,** it is likely that DTH services will be restructured under the larger deal with News. Since PanAmSat does not cover Mexico adequately, Televisa will have to rely on Solidaridad or Intelsat transponders.

The third player in Mexico's DTH market is the internationally unknown Medcom, using Scientific Atlanta technology and support. Medcom owners may be able to carve out a unique niche in the Mexican DTH market because they are popular for programming of Radio Red, a reliable radio news source in Mexico.

6. CONCLUSIONS

Mexico's information infrastructure has been greatly improved over the past five years due to the privatization of Telmex and the promise of competition in long-distance telephone service by 1997. Seeking a stake in market revenues of $4 billion per year, projected to grow 15% to 20% annually, these new competitors are expected to invest at least $5 billion over the next five years. To facilitate infrastructure development at the local loop, the Mexican government will provide incentives for cellular and trunking licenses to install more rural telephones under the footprint of coverage. Also, the privatization of Mexico's satellite system and the introduction of DTH satellite TV in 1996, will further enhance information infrastructure options in Mexico.

Palau Lightnet 2000 - A Telecommunications Revolution in an Emerging Nation

John J. Mariano
AT&T Submarine Systems, Inc.
Morristown, NJ

Karl E. Rye
Palau National Communications Corporation
Koror, Republic of Palau

Abstract

The Palau National Communications Corporation (PNCC) has developed a communications deployment plan, ***Lightnet 2000***, that addresses the telecommunications needs of the newly formed nation of Palau well into the 21st century. With noble goals of improving the general state of well-being for its inhabitants and seeking to attract foreign investment, PNCC is developing a high quality communications infrastructure. To achieve a reliable communications backbone, PNCC is installing an undersea fiber optic network integrated with its terrestrial communications system. The undersea system is a turnkey project encompassing the complete telecommunications network from survey to final acceptance testing. This paper addresses the PNCC telecommunications mission, the benefits of quality telecommunications to an island nation such as Palau, the attributes of the approach taken, and the experience gained during the project evolution.

Introduction

On December 15, 1994, the flag of the newly independent nation of Palau was raised at the United Nations after almost 50 years of U. N. Trusteeship under the administration of the United States. This event received global coverage through the international media networks using the worldwide communications infrastructure. As a young developing nation, Palau recognized the vital role that telecommunications plays in the information age. It has entrusted PNCC with meeting the ever-changing demands of regional and global telecommunications networks and their users.

PNCC, created in 1982, began with less than 200 customers (mostly government lines), annual revenues of less than US$70,000, a growing pending service order file of 400 requests, and an undersized and outdated phone system. Today, PNCC's annual revenues exceed US$4 M from over 2700 customers. Through a US$39M loan package from the U.S. Rural Utilities Service (formerly REA), PNCC has a number of important telecommunications projects under construction or in planning, including a 177 km undersea fiber optic ring around Palau. The undersea cable project is the main focus of this paper.

Mission Statement

PNCC has adopted a mission that embodies not only the needs of the telecommunications company but also its obligation to the community. Its mission is to:

"Integrate Palau into the global telecommunications network for the long-term economic well-being of the People and the Republic of Palau"

In order to achieve this mission, PNCC has embarked upon an aggressive program of improvement and expansion. The project, entitled ***Lightnet 2000***, has as its goal achieving a high quality, highly reliable local communications infrastructure. The economy of this new Republic can significantly expand and place an ever-increasing demand on the telecommunications system. PNCC expects to be providing over 7,000 telephone lines by the year 2000. This means Palau will have almost 35 lines per 100 residents, placing it nearly on par with developed nations.

PNCC's strategies for its telecommunications development are:

- Secure growth for the Republic of Palau by first enhancing its telecommunications infrastructure

- Attract external business investment by having an environment supportive of local and global communications capabilities
- Leapfrog from 19th to 21st century in terms of communications capabilities
- Be self-sufficient in network operation and system maintenance
- Maximize the implementation of proven technologies and telecommunications applications
- Actively promote undersea cable system projects that have a potential to be routed through the Pacific Rim region for possible connection to Palau.

Palau developed a multi-faceted project for enhancing its telecommunications infrastructure(1). It is doing this by developing a rural land network connected over terrestrial routes as well as a submarine cable providing inter- and intra-island connectivity. Figure 1 illustrates the undersea fiber optic communications system.

Because of the diversity of locations, the remoteness of some sites, and the desire to ultimately obtain high-bandwidth capability, undersea fiber optic cable became the natural choice. With the high bandwidth capability of fiber optics, Palau could then introduce applications such as distance learning and telemedicine, to enhance the well-being of residents and attract investment.

Telecommunications - A Link to Prosperity

Several examples where telecommunications accelerates economic development are presented to illustrate how PNCC will achieve its mission.

Benefits - Internal/External Investment

Advancing the telecommunications infrastructure will attract Multinational Corporations (MNCs) and other businesses to invest in a nation.(2) Upgrades must reflect the needs of all possible users in order to gain a wide range of support from possible investors. There exists an interdependency with the community and investors as illustrated in Figure 2. The example addresses the application of telecommunications to improving health care.

As the figure suggests, there is an interdependency among suppliers, business and users. Hospitals seek to improve the state of health for the community. Through good communications the hospital conveys health care policy or services (telemedicine, health care, education, etc.) The community benefits thereby achieving the original goals of the hospital. A plan for upgrading communications therefore needs to look beyond the immediate opportunity of increased telephone service. Cooperation among possible users will result in more support for the telecommunications industry to upgrade facilities.

Benefits - Health Care

Health care is critical in developing countries -- about 5% of all rural calls are for emergencies and medical reasons.(3) With proper communications, paraprofessionals using telecommunications lines between village clinics and regional hospitals and health centers can be accessible for consultation and supervision. This will enable remote expert diagnosis from central locations.

Connectivity and good communications among remote sites, like those existing in Palau, can be used to coordinate emergency assistance. This would be extremely important in the event of disease outbreak or during or after severe conditions such as typhoons. The benefit of saved lives and reduced suffering by better care through improved communications is immeasurable.

Benefits - Productivity

The telecommunications investment by businesses in the United States has provided excellent returns. For every $1.00 invested in telecommunications, companies saved an average of $1.64 in other costs(4). The added value has come from increased operational efficiencies and increased US and foreign sales.

Studies indicate that nations who have the "political will" to modernize and reinvest significant portions of their revenues will be successful (5). Telecommunications is critical to this development process. Networks and infrastructures of developed nations are being upgraded at a rapid pace in order to meet business demands. The gap between developed and developing nations is widening regarding availability of quality telecommunications. PNCC is seeking to rapidly decrease any gap and maintain parity with the global community.

Enhanced communications will prove beneficial to nations with varying amounts of industry. With current price information, business can accurately plan and schedule operations. Timely information also can lead to efficiencies in inventory levels or selection of downtime for maintenance operations.

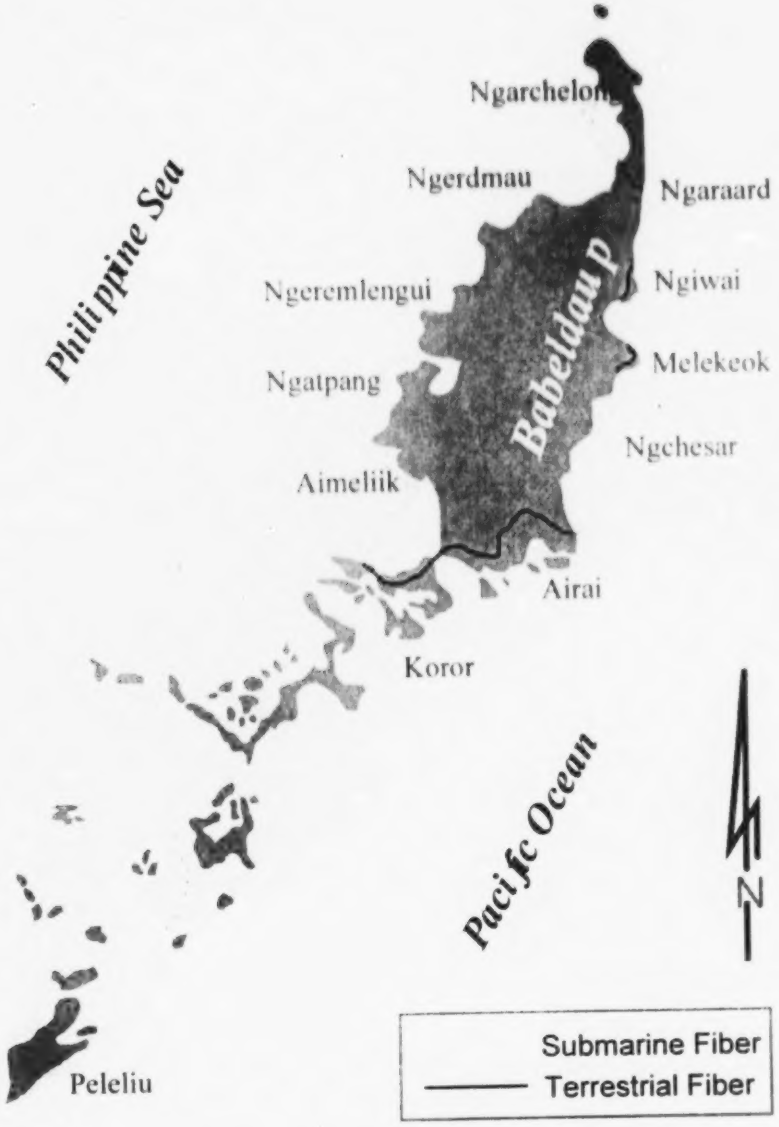

Ngarchelong
Ngerdmau
Ngaraard
Philippine Sea
Ngeremlengui
Ngiwai
Babeldaup
Melekeok
Ngatpang
Ngchesar
Aimeliik
Airai
Koror
Pacific Ocean
N
Peleliu
Submarine Fiber
Terrestrial Fiber

Figure 1 Palau Undersea Fiber Optic Network

Parts can be obtained at a low price with the ability to seek information from several suppliers. Communications could be the primary method for business negotiations thereby avoiding costly travel.

For large-scale businesses, operations can be either centralized or decentralized depending on the economics of each option. Extensive communications can allow for centralization of databases or applications thereby minimizing resource investment. Larger corporations needing support from remote sites, like an island nation such as Palau, can, with excellent communications, establish the necessary links.

Benefits - Education

By developing a communications infrastructure, distance learning can be introduced. Central education centers with a small cadre of qualified individuals can reach a greater number of geographically distant students with higher quality education. Good network capability encourages collaborative work. In the US, savings in time and cost have been ten times the cost of using the network. Avenues for research are "infinite" with access to global information networks such as information services, bulletin boards, electronic mail and other applications. For Palau, such an approach for education is being pursued.

Telecommunications Project Investment

Telecommunications project funding can come from several sources. Traditionally, PTTs funded projects. More recently, such projects are being funded by governments, industry, or private investors. In the case of Palau, US government funding was made available for this project. Investment from such sources requires that a strategy for development exists that reflects the interests of the potential investors. The strategy needs to be based on sound business development plans which identify those revenue enhancing services that will be provided. PNCC established such a strategy prior to embarking on its telecommunications upgrade.

The Palau Undersea Fiber Optic Network

An undersea fiber optic cable proved to be the best choice for PNCC to achieve connectivity of the remote sites around the big island of Babeldaup as well as connecting the key island of Koror and the remote island of Peleliu. The topology of this undersea non-repeatered fiber optic network consisting of 15 sites or network elements is shown in Figure 3. The network is essentially a physical ring topology except in the case of the link between Koror and Peleliu; which is a "flat ring" section (both sides of the ring in the same cable segment).

Each fiber pair in each of the segments will operate at SONET OC-3 or 155.52 Mb/s. The SONET OC-3 signal is made up of three (3) PDH DS-3 (45 Mb/s) or eighty-four (84) PDH DS-1 (1.54 Mb/s) input signals. The SONET architecture and the ring configuration assure continuous operation even in the unlikely event of a cable fault. Each site transmits and receives in two directions, so an alternate path is selected without service interruption. All submarine cable segments contain six (6) fibers each, and terrestrial cable segments contain twelve (12) fibers.

System Summary

Submarine Cable

A small diameter six fiber undersea fiber optic cable will be used (Figure 4). The cable consists of a core structure containing the six fibers, a steel strength member, copper cladding to provide a hermetic barrier, a polyethylene layer covered by a steel tape, and an outer high density polyethylene layer. This cable is a special application cable due to the presence of the steel tape that provides additional protection from sea bottom abrasion. Armoring of this cable will be provided in sections requiring added protection.

The six RXB fibers, will be provided. The separation of sites is modest with respect to optical transmission and does not require very low loss fibers. The nominal cable loss is to be less than .25 dB/km.

To minimize costs for cable manufacture and transport, the cables are to be manufactured to a specific length determined by its intended use and then put directly onto individual transportation reels. This minimizes cable handling in the factory and provides flexibility during installation operations. The total undersea system length is 148 km, divided into 16 cable segments.

The terrestrial cable, designated RL Cable, uses a lightwave cable core with an outer sheath consisting of a longitudinally applied corrugated copper tape (for lightning protection) laminated to stainless steel (for rodent and insect protection). Wrapped helically around the copper tape/steel lamination are 14 steel wires. Both the lamination and the steel reinforcement wires are bonded to a high-density polyethylene outer jacket that forms a compact and rugged structure. This cable has been

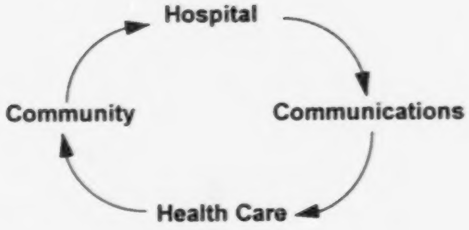

Hospital
Communications
Health Care
Community

Figure 2 - Telecommunications Interdependency

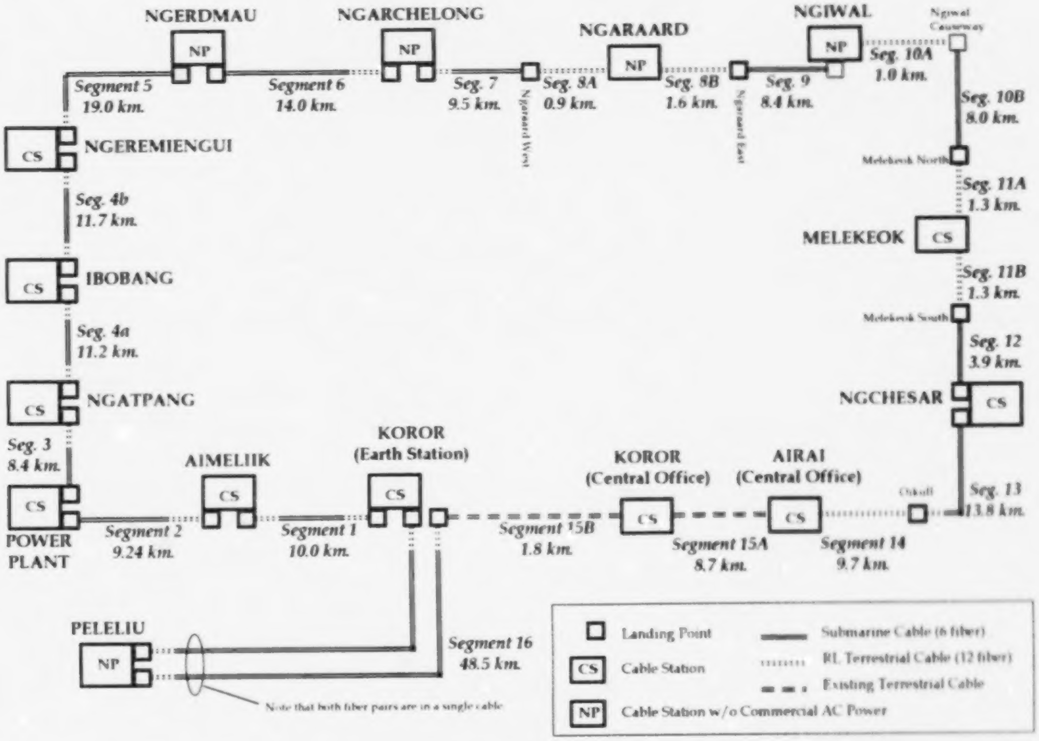

NGERDMAU
NP
NGARCHELONG
NP
NGARAARD
NP
NGIWAL
NP
Ngiwal Causeway
Segment 5
19.0 km.
Segment 6
14.0 km.
Seg. 7
9.5 km.
Ngaraard West
Seg. 8A
0.9 km.
Seg. 8B
1.6 km.
Ngaraard East
Seg. 9
8.4 km.
Seg. 10A
1.0 km.
Seg. 10B
8.0 km.
CS
NGEREMIENGUI
Melekeok North
Seg. 11A
1.3 km.
Seg. 4b
11.7 km.
MELEKEOK
CS
CS
IBOBANG
Seg. 11B
1.3 km.
Melekeok South
Seg. 4a
11.2 km.
Seg. 12
3.9 km.
CS
NGATPANG
NGCHESAR
CS
Seg. 3
8.4 km.
KOROR
(Earth Station)
AIMELIIK
CS
CS
KOROR
(Central Office)
AIRAI
(Central Office)
Oikull
Seg. 13
13.8 km.
CS
POWER PLANT
Segment 2
9.24 km.
Segment 1
10.0 km.
Segment 15B
1.8 km.
CS
Segment 15A
8.7 km.
CS
Segment 14
9.7 km.
PELELIU
NP
Segment 16
48.5 km.
Note that both fiber pairs are in a single cable
Landing Point
CS
Cable Station
NP
Cable Station w/o Commercial AC Power
Submarine Cable (6 fiber)
RL Terrestrial Cable (12 fiber)
Existing Terrestrial Cable

Figure 3 - Palau Undersea Fiber Optic SONET OC-3 Ring Network Topology

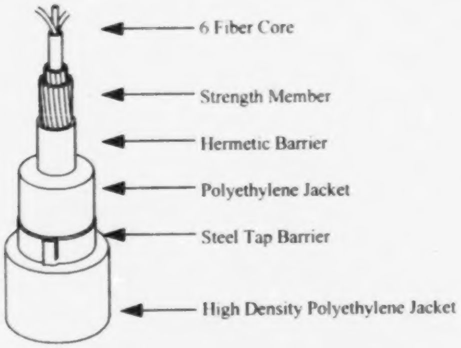

6 Fiber Core
Strength Member
Hermetic Barrier
Polyethylene Jacket
Steel Tap Barrier
High Density Polyethylene Jacket

Figure 4 Palau Network Cable Profile

used extensively for terrestrial applications. The total length of terrestrial cable to be used is 28 km.

Terminals

The equipment to be used is the AT&T DDM-2000 (Figure 5) product operating at OC-3 rate. Specific equipment for each site will vary depending upon location and the number of Optical Line Interface Units (OLIU) at each site.

The system being installed will allow for easy upgrades and expansion to meet future applications. The initial installation will be at the OC-3 level. As seen in Table 1, the typical use at this speed (155 Mb/s) is for modest speed applications. When future needs warrant upgrades, modules can be to progressively achieve the capability shown in this table. The basic transmission system will be over one fiber pair. There are three pairs (6 fibers) so there exists a significant upgrade capability beyond just terminal expansion.

Data Rate	Applications	Users
OC-3=3 DS3, 3x28 T1s, ISDN-BRF	Voice, data, low speed Internet, basic distance learning, fax	General public, education segment
OC-12=12 DS3, ISDN-PRI	High speed Internet, full distance learning, high speed fax, basic telemedicine	Business, banking, medical functions
OC-48=48-DS3, ISDN-PRI	Broadband video, video on demand, teleradiology	Entertainment, medical functions

Table 1 Capacity, Application and Users

The modular nature of this equipment minimizes cost for upgrade. All components provided in the basic offer are usable (and needed) for each upgrade. Upgrade equipment is purchased only when needed and not at the outset. As needs increase, readily available components are added.

Powering

The equipment needed for powering the system will vary depending upon the site.

- *Conventional Power* - Conventional available power will be used where available.
- *Solar Power Equipment* - A photovoltaic power system will be provided at several remote sites where conventional power is not available.
- *Diesel Generator Equipment* - Diesel generators will be provided as a secondary supply in the event solar or conventional power is unavailable.
- *Battery Power* - In all locations, battery backup will be installed to assure sufficient time for maintenance to remedy a fault.

Prefabricated Cable Stations

Since many of the locations are remote and without existing facilities to house telecommunications equipment, prefabricated buildings will be installed. At most locations, Containerized Cable Stations will be brought to a previously prepared site. The container to be used will be a standard 8' x 20' ISO Steel/Aluminum container with a coated aluminum finish. Where existing facilities exist, these will be outfitted with the telecommunications equipment.

Installation and Maintenance Vessel

Costs for installation were minimized by utilizing the maintenance vessel to be delivered as part of the project for installation as well. A maintenance vessel is provided to allow PNCC to perform system maintenance of the undersea cable.

Vessel Description:

The Palau cable installation and repair vessel (Figure 6) is a converted 46' transporter/landing craft. This size vessel is suitable for the operation since the cable is to be installed within the reef of Palau where water depths are shallow.

The aluminum vessel is equipped with a suite of cable handling equipment required to perform cable installation and system repair. Cable guides, modular cable handling equipment, and cable pans are installed for this purpose. The vessel will be equipped with GPS navigational equipment that provides the necessary accuracy for installation and subsequent repair operations.

Training for PNCC personnel in operation, administration, maintenance, and provisioning will be provided. PNCC will ultimately be fully responsible for all aspects of the telecommunications system.

Key Success Factors for Palau

Several factors lead to the success of the project thus far. During the initial phases of the project, frequent discussion with PNCC and potential suppliers provided them with the necessary understanding of undersea fiber optic applications. Through a telecommunications consulting firm, final system specification was developed. Continuing interaction between PNCC and the system supplier allowed for a cost effective solution to evolve. Cost saving alternatives evolved out of continued open technical discussion. A flexibility on the part of the customer and the supplier allowed for a final configuration to emerge that was lower in cost and mutually acceptable to both.

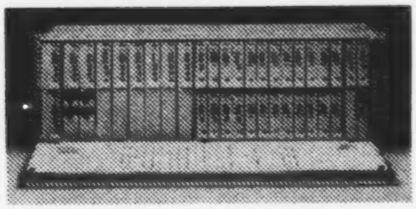


Figure 5 AT&T DDM-2000 Multiplexer/Transmitter

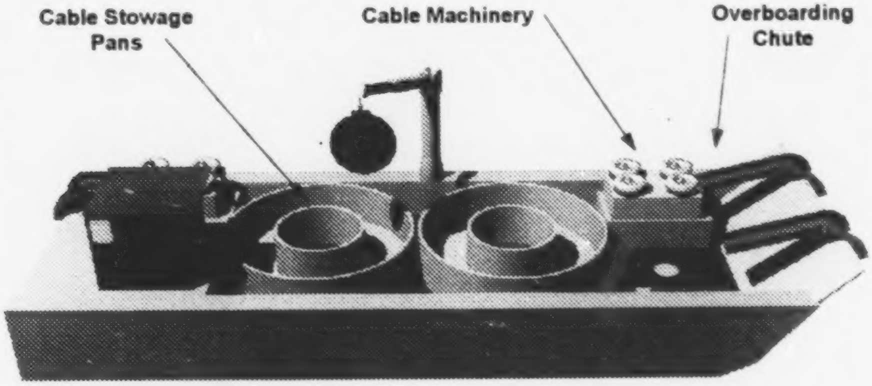

Cable Stowage Pans
Cable Machinery
Overboarding Chute

Figure 6 - Installation and Maintenance Vessel

166

Options that minimized costs were:

- Turnkey project where one supplier was responsible for the entire project from survey to final acceptance test.
- Submarine Fiber Optic Cable over alternatives such as radio and other terrestrial links.
- Implementation of a versatile and expandable architecture
- Containerized Cable Stations where economics of scale minimized costs
- Reel stowage and transport of the cable system
- Flexibility in developing and finalizing the specification.
- Maintenance Vessel used for both installation and subsequent maintenance.
- Maximize the use of proven technologies and techniques were used.

Global connectivity - *The Next Step*

Once Palau has established its telecommunications infrastructure it can approach the global network community with more to offer thereby influencing the planning of undersea networks.

Planning of undersea cable systems is being performed by a diverse community. Cable suppliers, investors, telecommunications companies and others identify potential cable systems by determining needs for connectivity. Such projects will arise if the economics are good and if these planners are aware of the goals of nations to be connected. Therefore, an important element to securing connectivity is communicating the desire. For this reason, PNCC continues to actively lobby for projects in the region that have a potential for connecting them to the global network.

Summary

Palau's vision is being realized by implementing several digital communications projects where the undersea fiber system is a key element. It will result in:

- high quality, cost effective digital communications for the nation
- a platform on which emerging applications can be used to enhance the well being of the people of Palau
- an economical path for upgrade
- an attractive basis for linking to the global network

While the Republic may have suffered with an outdated and undersized telephone system for many years, PNCC can state with confidence that it will have been well worth the wait. Through progressive and innovative projects such as the submarine cable network, PNCC is taking this opportunity to build not just a good telephone system, but is building a superior telecommunications network: one that will carry Palau into the 21st century and beyond. Furthermore, Palau will have one of the most advanced networks in this region, comparable to those serving leading economies of the world. The emerging network entitled **"Ukedel a Llomes 2000"**, literally meaning the "Net of Light" provides such advance capability.

Lightnet 2000 is as much a philosophy as it is a communications network, reflecting PNCC's commitment to providing "Universal Service." To PNCC, universal service means providing advanced communications services from every corner of the nation to every corner of the globe... anywhere people of Palau chose to live ... today or tomorrow.

References

(1) Rye, Karl E. "Overview of Telecommunications in the Republic of Palau," Palau National Communications Corporation publication, 1995

(2) McGovern, Patricia M., and Herbert, Paul "Telecommunications and Economic Development," Telephony, November 1992

(3) Hudson, Heather E., "Telecommunications and the Developing World", IEEE October 1987 - Vol. 25, No. 10

(4) Cronin, Francis J., Herbert, Paul and Colleran, Elisabeth "Linking telecommunications and Economic competitiveness," Telephony, September 1992

(5) Winsbury, Rex. "Who will pay for the Global Village? Funding the Buenos Aires Declaration," Intermedia, June/July 1994/Vol. 22 No. 3

The Information Infrastructure Meeting the Need of Bangladesh

Fazlur Rahman
Dhaka, Bangladesh

1. ABSTRACT

The industrial revolution gave a premium to concentration and centralization of production. The transition to an information economy is now reversing that trend. With the latest technological developments in the Telecommunication sector and convergence of Information Technology, it is now possible to create and transfer a working place any where at will, by adopting Teleworking.

2. EXECUTIVE SUMMARY

Bangladesh, with a population of more than 118 millions cramped within an area of about 144000 square kms. is one of the densest populated areas of the world. It has a population density of about 820 per sq. km. The country is devastated by natural calamities like floods, cyclones, and tornadoes almost every year. The main cash crop, Jute, has experienced decline in price in real terms drastically over the last several decades. Lack of infrastructure, too much natural calamities, lack of resources, caused Dr. Henry Kissinger to call Bangladesh, after it was born in 1971, a bottomless basket. But the Information Technology is reversing the situation. With the latest technological developments in the Telecommunication and Information sectors, it is now possible to create and transfer any working place of the world, at the door steps of the developing countries. The new Global Information Infrastructure practically transformed Bangladesh (for that matter any place on the earth), as a part of the global working place. These are now possible, with the wide ranging exploration, implementation and utilization of information technology. These changes are bringing opportunities as well as threat to all of us, particularly to those living in the developing countries. The opportunities are for those able to anticipate and develop a competitive positioning; those capable to timely understand and use tremendous potential for development of the Information Infrastructure.

3. SITUATION IN BANGLADESH

3.1. BOTTOMLESS BASKET

With per capita income of about US $ 250 per year, the economy of Bangaladesh is one of the poorest in the world. The infrastructure is still in an infant stage. Vast majority of people of Banglasesh lives in the rural areas. Therefore in order to develop the economy of Bangladesh, its rural area must be developed. But the prevailing feature there is mass poverty, very poor access to basic infrastructure, scanty social and human services, and poor prospect of welfare improvements and growth. Poverty entails lack of access to the necessities of the life like food, shelter, health care, and recreation. It is the result of lack of access to the means of production or jobs, where the poor could procure its necessities. The total utilized agricultural area in Bangladesh is getting reduced, and the number of people employed in agriculture is declining. With no surplus land available for agriculture, the major problem faced by the people is the non-availability of employment opportunities. The problems outlined are not just problem for the rural regions, they are more of a social nature. For the rural areas, are not the appropriate place where people may live and work, except for agricultural work which can absorb only a fraction of the workforce of Bangladesh. The net result is that the percentage of those below the poverty line in Bangladesh are increasing rapidly. For survival rural people migrate to urban areas creating ecological

168

unequilibrium in the society and environmental pollution.

4. RURAL CHARACTER

This means that the country side of Bangladesh must be preserved, not only as an agricultural production areas or as recreational areas, but it should also provide adequate opportunities for business and cultural possibilities, based on social structure of village communities. The dominating and irreversible concentration of agricultural business and of economic and social activities in general means that the future rural society very much depends on the diversification of rural economies. Generally, the attraction of small and medium sized enterprises is hampered by difficulties which are not only a matter of small size and lack of resources, but which are also a matter of such factors as geographical and socio- cultural distance from markets and decision-centers, lack of easy access to information, lack of appropriate services (public services, training programs, etc.), lack of training facilities for the work force, and lack of links with other firms. It has to support the existing firms with services and training, as well as create new jobs by attracting small and medium-sized enterprises to the rural communities and businesses to the rural areas, and maintain the variety of private and public services. This is vital for preserving the rural society, and to reproduce the social complexity, thus counteracting the trend towards monoculture.

4.1. RAY OF HOPE

The access to high quality telecommunication services and the use of the Information Technology, in the rural areas can bring quick change and will be attractive and comfortable, for the entrepreneurial people to live and do business. This will result in increased local industrial and business activities and create new jobs. The linkage effects and the importance of information shall increase the productivity. With the information flowing speedily, the market condition shall determine the production, business and distributions effectively. The village people are mostly commercial or subsistence farmers, but they are ingenious. With the availability of Information Technology, it is expected that agro-industry would be strengthened and developed more ingeniously. Those who had to migrate to city areas for jobs. shall be attracted back to the villages. The emergence of agro-industry with skilled people and investments into the villages shall result in economic activities for self reliant and sustained economic growth.

5. CHANGING TREND

Though slowly, the situation is now changing in Bangladesh. Given below are some examples, showing how the uses of Information Technology are meeting the special requirements of the developing countries like Bangladesh :

- Shahida got married as a child at 11. In 1986, Shahida underwent an adult literacy course. With the help of numerical and literacy skills, she keeps her personal accounts and routine works updated. She is now a poultry vaccinator, a vegetable grower, and a family planning volunteer. She bought a treadle pump (foot operated tube well) and learnt to grow vegetables and fruits like guava, papaya etc. round the year. All these have not happened automatically. Shahida went through several training courses and tried to apply in her own life whatever she learnt from each of the courses. Now she is enjoying the fruit of her labour , and owns her personal land. A dream comes true.

- Kaliganj, a small remote market place, in the district of Jhenidah, lies in the south western part of Bangladesh. This area grows banana. But there was little market information. The business was sluggish. With a small manual telephone exchange and a physical trunk line, the telecommunication was difficult. There used to be on an average of about 5-6 trunk calls per day. With the opening of the Operators Trunk Dialing (OTD) facility at Kaliganj, the average trunk calls went up to about 60 calls per day. A few months back, the manual telephone exchange was replaced by a small digital PABX. The subscribers are now able to dial directly to other parts of the country, but the incoming calls

169

are still restricted via the operators. However, the average trunk calls per day shoot up to about 600 calls per day. The banana business is flourishing and there is a steady upward trend in the bank savings in the area.

- Bhanga, is a small Thana (Police Station) head quarter in the Faridpur district of Bangladesh, with little economic activities in the area. The young adults of the area cannot find any job there and go elsewhere in the country as well as to abroad for employment. The other day, the parents of such a boy came to the Public Telephone Call Office at Bhanga to receive a call from their son living at Dubai, UAE, with a view to finalizing the marriage proposal of their son. This would have been impossile a couple of years back.

- A garment factory at Dhaka, Bangladesh employing 97% of their staff from women, received an urgent advise from its foreign client to change the design of the apparel to meet the changing fashion in Europe. This could be modified just in time because of the availability of Fax telecom facility and delay of couple of weeks period could have been disastrous.

- With the starting of the Data Entry business recently in Bangladesh, the young workers of Bangladesh are now able to input the business data of the firms of USA and send them back there, working right in Bangaladesh, thus effectively transferring the working place from USA to Bangladesh.

- In a remote village in the southern coastal belt of Bangladesh diarrhoea broke out and there was no doctor available there. With the telecommunication facility recently installed in the nearby area, the Doctors from Dhaka, the capital city, could provide medical advise and oral saline was administered to the patients without delay and thereby a catastrophe could be avoided.

6. ACCESS TO TELEMATICS & TELEWORKING

6.1. THE INDUSTRIAL REVOLUTION

During the early part of this century, the industrial revolution gave a premium to concentration and centralization of production. The transition to an information economy is now reversing that trend. The convergence of Telecommunication and Information Technology (Telematics) has made it possible to undertake the process of re-engineering the functions, and business activities that have a strong synergistic relationship. It is now possible to diversify different functions of an industry or an entrepreneurship and thus providing much more flexible and de-centralized business and non-business organizations and working practices (Teleworking). Concentrating in what one does best inevitably involves the out-sourcing and sub-contracting of professional services which are not essential or not continuously required. Telework technologies now make this possible. Competitive advantages lies now in the use of telecommunication and information technologies. The driving forces behind this re-structuring process are the need to get closer to the functions / customers, make better use of skills / increase flexibility, and reduce fixed costs / concentrate in core competencies. Getting closer to the function, as well as to the customer, means being more responsive to rapidly changing and more value-added oriented demand and requires better communications, better integration of development, production and marketing, for which the effective use of Telematics is essential. The better use of skills involve not only the delegation of responsibilities and removal of layers of management, but giving people more flexibility to apply their skills where and when required. It also necessitates a continuous up-grading of skills as a part of normal work. The convergence of telework and tele-training systems supports all these new needs. These trends underlay a dramatic change in the production system, methods of organizing work and setting consumption patterns that will have long term effects comparable with those of the first industrial revolution.

6.2. TELEMATICS

The possibilities of accessing the necessary information remotely and their applications in evreyday life, as well as the accelerating pace of technological innovation over a widening spectrum of applications, can provide new opportunities which affect our ways of working, living and thinking drastically. Such essential functions like health care (telediagnosis, health sector networks), education (computer based training, distance learning), scientific research (worldwide inter active networks by disciplines), business transactions (electronic data / information exchange, electronic banking), production planning (concurrent engineering), and transport (logistics, scheduling, (re)routing), as well as applications of teleworking,- conferencing,- design, - and editing, as substitute for transport with related time / energy savings, are now possible comparatively easily , even in the developing countries like Bangladesh with the use of Telematics.

7. THE INFORMATION INFRASTRUCTURE

It is now possible to concieve small business ventures at the National / Global level and that could trigger the economic recovery and create new jobs. Small business companies with high knowledge content in their products and services, can expand by serving markets countrywide via Telematics applications running on an advanced national communication infrastructure. The main impact of teleworking will apply to the small business sector to the enhancement of their operations in overcoming distance and serving new markets via Telematics. The requirement now is a new vision for advanced industrial societies, a new covenant between the public and private sectors, and a new balance between urban and rural areas, a new spirit of cooperation between rich and poor people, and between North and South. The deployment of **National / Global Information Infrastructure** networks and the application of the new Telematics technology could now provide the platform for a national / global resurrection.

7.1. THE VISION

With the latest technological developments in the Telecommunication sector and convergence of Information Technology, it is now possible to create and transfer a working place of any where in the world, even at the door steps of the developing countries by adopting Teleworking. This should benefit the entire human being as a whole. However, this change could bring opportunities as well as threat to all of us, particularly to those living in the developing countries. The opportunities will be for those able to anticipate and develop a competitive positioning; those capable to timely understand and use tremendous potential for development of the Information Infrastructure. It is for us to grab the opportunity and to take actions accordingly.

Acknowledgement

Subject	Source
Community Teleservice Centers : A means to social, cultural and economic development of rural communities and low income urban settlements	Mr. Lars Qvortrup, Telematics Project, Odense University
Towards a "Common agenda on Telematics and Teleworking.	European Community Telework / Telematic Forum
Towards a policy toolkit to meet rural development goals in a liberalized environment for Latin America	Canadian International Development Agency's Paper in WTDC-94
From Rio to Buenos Aires for sustainable development and the role of Telecommunications	Tunisia's paper in WTDC-94
The Missing Link - INFORMATION	Canadian International Development Agency's paper in WTDC-94
Partners in Development, Telecommunications- The First Link	Message from the Telecommunication Development Advisory Board of ITU.
Telecommunications and Development	The role of European Union in WTDC-94.
Telecommunications and sustainable Development	Huguette Labelle, President, Canadian International Development Agency.
Integrated Rural Development through Telecommunications Development initiatives.	Indonesia's paper in WTDC-94.

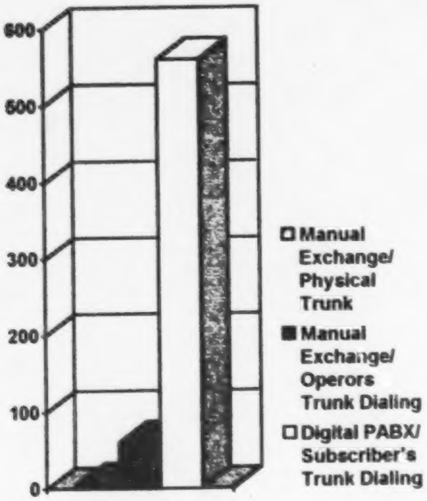


Fig. - 1
Growth in Telephone Trunk Traffic per day
with better Infrastructural Facility
at Kaligang, Bangladesh.

Fig. - 2
Treadle Pump
A Foot Operated Tube Well

Fig. - 3
A Garment Factory
Most of the shirts and T-shirts worn in EU are made in Bangladesh.

EVOLUTION OF INFORMATION NETWORKS
AND
FUTURE TRENDS IN INDIA

R.N. Bharadwaj
G.M.(SATCOM PROJECT)
Department of Telecom, Calcutta

N.K. Srivatsava
Dir (SATCOM PLANNING)
Department of Telecom, Delhi.

ABSTRACT

Information networks are being setup matching with available technology. Custom built networks are in operation. With the advancement of communication and information technology , the networks are merging . Towards the first decade of 21st century, wide band networks with multimedia applications are expected to be realised.

1. INTRODUCTION

Flow of information by various modes of communications from the time immemorial has been shaping the life of human beings and its environment. Today when means of communication are reaching to new heights of development, flow of information has become more important and critical to facilitate faster pace of development in each sphere of life and its surrounding environment. Availability of information as useful resource, is one aspect and its timely flow to the concerned is the key of success.

In India information facilities and networks are being engineered to :
-meet socio-economic development of remote and rural areas.
-supplement inter-urban network facilities for business communications.
-create new facilities in unserved areas for safety and better management of high cost and high-risk assets of oil exploring agencies on land and in off-shore areas, mining and power sectors.
-develop infrastructure for promoting agriculture. and horticulture etc.
- link places of historical and touristic importance.
-broadcast information bulletins for health, education and weather reporting.
-assist administration for law and order and management of public utility systems.

Integrated information networks are evident along with voice and image transmission. Technology for cost-effective networks was evolving.Therefore number of independent custom-built networks were conceptualised, designed and implemented. Current studies indicate need for integrated information and communication networks facilitating
-Transfer of information
-Collection of information and data
-Transfer of documents and images
-Entertainment
-Multi media applications with Narrow-Band and Broad-Band Systems.

The networks are expected in star and mesh configurations. Networks being visualized for first decade of 21st Century are broad-band to serve the needs of multi-media applications. Currently narrow-band system is being implemented for multi-media applications.

Information networks in India started with transmission-rates of 1200 bps leading to 64 Kbps and 2 Mbps. Satellite based mesh-networks with 64Kbps transmission rates are under implementation by private licenced operators as well as Dept of Telecom. Terrestrial based network is going to offer upto 2 Mbps speeds for various applications.

Special satellite networks for weather data transfer, Disaster Warning System (DWS), Education and Research Network (ERNET), Agromet Advisory Network (AANet) for medium range weather forecast, etc.are being implemented progressively.

2. NETWORKS & SERVICE OFFERINGS

The networks in operation / under implementation

173

offer variety of services summarized below :-
- Scientific R&D applications.
- Data transfer at medium/high speeds.
- Electronic-Mail transfer.
- Information Retrieval, Database Access, Remote job Applications.
- Remote log-in, Directory services.
- Credit card verifications
- Tele-travel reservations
- Electronic bank-transfer
- Interactive-computing at high speeds upto 64 Kbps
- File transfer
- News Bulletine Boards
- Limited voice capability.
- Transfer of advance information regarding cyclones and storms etc.
- Weather based favourable data transmission to Agromet centres.
- Collection & dissemination of Meteorological, Hydrological and Oceanographic data from remote and un-inhabited locations over the land and sea.

3. PERFORMANCE OBJECTIVES AND LINK DESIGN

Most of the networks are engineered in accordance with ITU-T and ITU-R recommendations on availability and performance. Hypothetical Reference Circuits (HRCs) definition has been maintained as per established norms. However certain satellite networks have been designed with lower values offering efficient use of satellite resource and small size terminals. The design value meet service requirements. Networks falling in this category are SBRTN, DWS & DCP etc.

In case of DWS, un-companded Signal-to-Noise ratio for peak signal has been fixed as 40dB. DCP link is designed with over all bit-error probability of 10^{-6}. Probability of collusion from other DCPs when individual DCP is transmitting is less than 10^{-3}. The overall probability of data reception for the system is 95% or better. For cloud imageries over all BER of 10^{-4} is essential requirement. For STFS transmission, S/N objective of peak signal is maintained as 50 dB with FM modulation. HV-Net and RABMN are designed tooffer 10^{-7} BER and availability of 99.99% I-NET provides error-free service. Main characteristics of selected satellite based networks are summarized in table-1.

4. TOPOLOGY OF NETWORKS AND TECHNOLOGY

4.1 ARCHITECTURE OF I-NET

I-Net is India's Public Switched Public Data Network (PSPDN). Its phase-I in operation was engineered with 8 nodes. It meets the needs of 150-200 organizations. It connects about 2000 terminals/ computers.The type of access & transmission speeds offered are :

(i) X25
(ii) X28(direct) - 300 bps to 4800 bps
(iii) X28 (PSTN) - 300 bps to 2400 bps

The network offers PSTN dial-out service, 099 access from other locations, dedicated dial-up, Mail-back facility etc.

Phase-II of I-Net is under implementation on country wide basis Network is to interwork with ISDN switches & act as Packet Handler. It will also offer Telematic services. Addressing schemes are based on ITU-T X121 & X122 recommendations. Quality of service in terms of Delay, Availability etc. are in accordance with ITU-T recommendations and other applicable International standards. The Access and associated transmission speeds are :

(i) X25 Access	- 2400 to 64000 bps
(ii) X28 Access	- 300 to 9600 bps
(iii) X75 Access with MLP	- upto 4 x 64000 bps
(iv) X32 Access	- upto 9600 bps
(v) X31 for ISDN	- case B mode
(vi) X25 Access	- Gateway
(vii) X22 Access	- Multiplex access

I-Net Phase-2 provides coverage to 89 cities and offers transmission at 64 kbps and 2 Mbps for selected applications. This network is going to offer new features and flexibility given in table-2. Network uses type-1 switch having 1000 ports with inter-linking capability to similar switches via high speed 2048 Kbps trunk lines or concentrators. The type-2 switch has 128 ports with inter-connection capability to similar switches. All port share trunks in common pool. Subscribers can access the switch through remotely located concentrators with 32 ports. Some of the switches may act as transit switch. The Frame Relay access to such switches is to work from 64 kbps to 256 kbps. The Frame Relay nodes are connected by 2048 kbps lines with physical interface of V35/G703.

TABLE -1

CHARACTERISTICS OF NETWORKS

NAME OF NETWORK	ACCESS TECHNIQUE	TRANSMISSION RATE	MODULATION	YEAR OF OPERATION	REMARKS
SBRTN	TDM-TDMA	1200 bps	BPSK	91-92	DUPLEX (DATA)
RABMN	TDM-SSMA	IN-BOUND : 64kbps OUT-BOUND : 153.6 kbps	BPSK	91-92	DUPLEX (DATA)
HV-NET	TDM-TDMA	IN-BOUND: 64 kbps OUT-BOUND : 512 kbps	GPSK	95-96	DUPLEX (DATA, VOICE and VIDEO)
DWS	FDM/ FDMA	TWO DATA CHANNELS AT 2400 bps and TWO VOICE CHANNELS	FSK-FM	80-81	BROADCAST MODE, TRANSMISSION TO REMOTE COASTAL DWS RECEIVER SITES (DATA and VOICE)
DCP	RANDOM ACCESS	4800 bps DCP	BPSK	80-81	BURST MODE TRANSMISSION FROM DCPs (SIMPLEX DATA ONLY)
SDUC	LEASED LINES	VOICE GRADE LINKS FOR SDUC(2400 bps)	VOICE BAND MODEMS (SDUC)	80-81	DUPLEX (DATA, VOICE and VIDEO)
ERNET	TDM-TDMA	IN-BOUND : 64 kbps OUT-BOUND : 512 kbps	QPSK	94-95	DUPLEX (DATA, VOICE and VIDEO)
AGROMET ADVISORY NET	TDM-TDMA	IN-BOUND : 17 kbps OUT-BOUND : 64 kbps	MSK	93-94	MEDIUM RANGE WEATHER FORECAST

Type-1 switch has capability for 100 originating, terminating or transit calls. It supports 60 links with X75. Through put of switch is 4000 data packets per second. It supports about 100 trunks of 64 kbps.

4.1.1 INTER NETWORK CONNECTIVITY

Networks are engineered with appropriate interface equipment and protocols to facilitate inter-network connections. The I-NET phase 1 and 2 inter-work with the terrestrial and satellite networks. Protocol and interfaces for inter-working are indicated in table-3. The international traffic is routed to Gateway Packet Switching System (GPSS) and transmitted over international links.

4.2 SATELLITE NETWORKS

The brief topology of the satellite networks is provided in this section.

4.2.1 Remote Area Business Message Network (RABMN)

It employs Spread Spectrum Multiple Access(SSMA) Technique. Master Earth Station(MES) with G/T of 31.7 dB/oK has a packet switch and sets uplinks in two hops among remote VSATs. It provides PSTN and GPSS connectivity in single/double hop. Host computer of users are linked to host computer interface of the Network at MES. It transmits 153.6 kbps out-bound TDM carrier which is received by VSATs with G/T of 11.2 dB/oK.

VSATs can receive data upto a maximum rate of 19.2 Kbps. VSATs transmit user's data in packetized form at 1200 bps to MES. Each VSAT has two ports which can independently be operated with same or different protocol. Network supports X25 protocol. At VSAT node a built-in packet Assembler /Disassembler (PAD) is available to permit connection of upto two asynchronous user terminals. X25 Interface can be dynamically configured from operator console by setting parameters at the interfaces. The interfaces available are given in table-4.

4.2.2 HV NET

Network uses TDM-TDMA technology.MES with 31.7 dB/oK G/T transmits 512 Kbps out bound carrier which is received by VSATs of 15.5 dB/oK G/T. VSATs transmit in TDMA-mode at 64 kbps. Each out-bound carrrier can support upton 32 in-boundn carriers.

A packet switch is available at MES & packet based protocol operates between MES & VSAT data ports. The VSAT has following port configurations :
-Standard - Upto 32 ports with multicard option
-Voice port
-Video IF port

To support X25 function, following interfaces are provided :
Data - RS 232, R422 and V35
Voice - Four wire E & M
LAN - Ethernet, UTP coaxial
Token Ring Type 1 & 3

Asynchronous data upto 19.2kbps and synchronous data from 1.2 to 64 kbps is transmitted.

4.2.3 ERNET

Nation wide network is for academic and research institutions for better design and development.
The main objective is to provide enhanced computer networking with associated emerging Information Technology(IT) concepts.

Satellite based wide Area Network (SAT-WAN) is with TDM-TDMA technology. The concept of multi-vendor inter-operative inter-networking architecture based on ISO/OSI is adopted. In the initial phase 8 campuses of Institutions with LAN, WAN and packet radio based MAN form the sub-networks.

The network meets the needs of Indian academic and research institutions and of collaborating organizations for research, development and experiments.Technical characteristics and configurationof the network are similar to HV NET.

4.2.4 SPECIAL NETWORKS

(i) DCP AND SDUC LINKS

Information on meteorological, hydrological and oceanography is collected from remotely located data collection platforms (DCPs) via satellite receive

TABLE -2

MAIN CHARACTERISTICS OF I-NET 2

ACCESS INTER FACE	MODEM INTERFACE	FACILITIES
X.25	V 22 bis . V 29. V 32 bis. V 35	Frame Relay. Reverse charging. Fast select . Close User Group . Call deflexion. Abbreviated address calling.Hunt Group. Multiple packet sizes. Network User Identification.
X.32	V 32 bis	
X 28 (leased line)	V 22 bis. V 32 bis or data over voice	
X 28 (Dial up mode)	V 21. V 22 bis or V 32 bis	
X.75 (International Access)		

TABLE - 3

INTER NETWORK INTERFACES

NETWORK	ACCESS INTERFACE / PROTOCOL
PSTN	X25 (Direct. via X 25 pad). X 32. X 28 (via X3 pad) dia-up mode and dedicated access
RABMN	X 25
HVNET	X 75 or X 25
ISDN	B & D Channels
International GPSS	UNI

TABLE - 4

RABMN INTERFACES

MES Serial ports for X25 working	VSAT Serial ports
X 21 bis	X 21 bis
RS 232 C (V 24. V28. ISO 2100)	RS 232 C (V 24. V28. ISO 2100)
RS 422A (V11,X27)	RS 422A(V11. X27),ASCII start-stop protocol

TABLE - 5

STFS - ACCURACY AND PRECISION

Accuracy of time or Absolute time	Less than 25 micro sec.
Precision of Measurement	Less than 5 micro sec.
Accuracy of frequency measurement	Less than 1×10^{-10}
Precision of frequency measurement	Less than 1×10^{-11}

only terminals. DCPs transmit processed & formatted data in random access and in sequential order with very low probability of collusion. Transmission from DCPs is at 4800 bps in UHF-band. Down link reception at MES is in 4GHz-band. This data is processed and disseminated in usable form on leased lines and also via satellite receive only terminals.The information is in the form of data and images.

(ii) DISASTER WARNING SYSTEM (DWS)

It is designed to issue timely messages and warnings of impending disasters from cyclones, storms, floods etc. Coded receivers in the areas of concern are addressed through MESs. The receivers have unique code. Address message initiates an audio alarm attracting attention of local attendants. Transmit up-links are in C-band and receive down-links in S-band. The siren/audio alarm and receiving amplifiers are switched off automatically after pre-determined period. MES transmitter employs FM transmission for multiplexed data and voice signals.

(iii) AGROMET ADVISORY NETWORK

Network provides for exchange of Medium Range Weather forecast (say for next 2 or 3 days) to Agromet Centers located in Agriculture Universities, remote sites and collect information on soil conditions, status of crops etc. TDM - TDMA technology is used. Central Earth Station (CES) transmits TDM Carrier at 17 kbps. Agromet centres have VSAT with G/T of 15 dB/oK and equipped with PC/Processors for interactive computing by meteorological and agricultural scientists accessing host-computer. Information between Met office/CES and VSATs is exchanged on various parameters. Information transmitted from Met office/CES contain preventive suggestions/actions to minimize the damage to Agricultural/Horticultural produce expected directly or indirectly from adverse weather conditions. The return links from VSATs and Agromet centres, provide soil and crop conditions. This return data and computer based weather prediction suggests measures for optimizing inputs to the farms for irrigation, fertilizer and spray of pesticides etc. and schedules for activities like ploughing, sowing, harvesting etc.

(iv) FLOOD FORECASTING NETWORK (FFNET)

The network offers improved flood forecast and in turn capability for water management. The DCPs are provided in rivers, catchment areas and reservoirs and large tanks etc.

The rainfall data and water levels are tele-processed through Central Water Commission's centre on 24 hours basis. Central station interrogates DCPs at predetermined intervals (30 minutes or 60 minutes). The Central station's Master teleprocessor is a micro-computer and linked with a modem. The DCPs are solar powered. System uses PCM-BPSK modulation and PCM (NRZ) Manchester coding. Rain fall/ water level sensors output is processed as 12 bit data. System is similar to DCP system.

(v) STANDARD TIME AND FREQUENCY SIGNAL (STFS) DISSEMINATION

Standard Time & Frequency Signals dissemination via satellite for research Institutes & Universities by National Physical Laboratory facilitates highest order degree of accuracy. MES broadcasts coded 1KHz signal burst every second and a continuous tone of 5KHz. Each coded time pulse carries one bit of information and the entire message is sent over 59 seconds. Message carries time of the day and current satellite position information. Uplink from MES is in C-band and down link in S-band. Accuracy of time and its precision achieved are given in table - 5.

System employs FM modulation. STFS receiver is a small terminal(G/T of 8 dB/oK)with decoder capable of extracting time information. The phase of local standard is compared with received signal. The system offers accuracy as required by R&D institutions and for synchronization of the Telecom Network.

5. SOCIO-ECONOMIC EVALUATION

The social and economic benefits are analyzed here on the basis of geographical coverage, standard of masses, needs of industries, institutions. In rural and remote areas hither to unserved by communications

In rural and remote areas hitherto unserved by telecommunications satellite networks offer basic telegraph service. The networks proved helpful and assisted in welfare, exchange of messages,law and order maintenance, management of developmental schemes.

Money order transfer by RABMN from remote sites has added an excellent socio-economic feature. It is also used by Mining, Oil and Power sectors.The improvement in efficiency of these organizations is estimated in the range of 10-15%, enhancing production and turn-over significantly.

These networks have facilitated on-line monitorning of production, raw materials, manpower-management, distribution network of products & services. This has contributed significantly for enhancement of organizational efficiency, plant-utilization and production.

Agriculture sector is benefiting tremendously. The enormous losses encountered due to rain, storm etc. are getting minimized by Medium Range Weather Forecast.The service provided through DWS during disaster is valuable & need not be quantified.

6. FUTURISTIC TRENDS

As mentioned in introductory paragraph, need based networks driven by available technology came into existence. Progressively in last 5 years many networks like HV NET, ERNET and I-NET Phase 2 with latest technologies & much better capabilities became reality offering wide range of services.These networks are now expected to merge with backbone telecommunication network. Plans are drawn up for multi-media applications with narrow-band links, switches and associated terminals. Extension of 64 kbps & 2.048 Mbps links to customer premises is realised to offer :

PC - Multimedia
Video conferencing and scientific services.
Entertainment - Video and Music on demand
Tele-shopping and Tele-education .

Telecom network is expanding with new features and characteristics. Wide-band long distance SDH links and new technology switches will create a base for broad-band ISDN and Multimedia systems in the first decade of 21st century. Information Technology Systems & Telecommunications are to merge with the exception to specific applications via satellite.

7. CONCLUSION

Growth of information networks has been slow but with wide variety of applications and services. Satellite networks provided many new services promoting fast growth, assisting R&D sector, Human Welfare, Public Administration & weather forecast against impending dangers of the nature. Networks proved to be boon for various sectors of the society. With the growing importance of information transfer in present day economy, led by privatization and deregulation, it has become essential to enhance facilities and offer new and value added services.

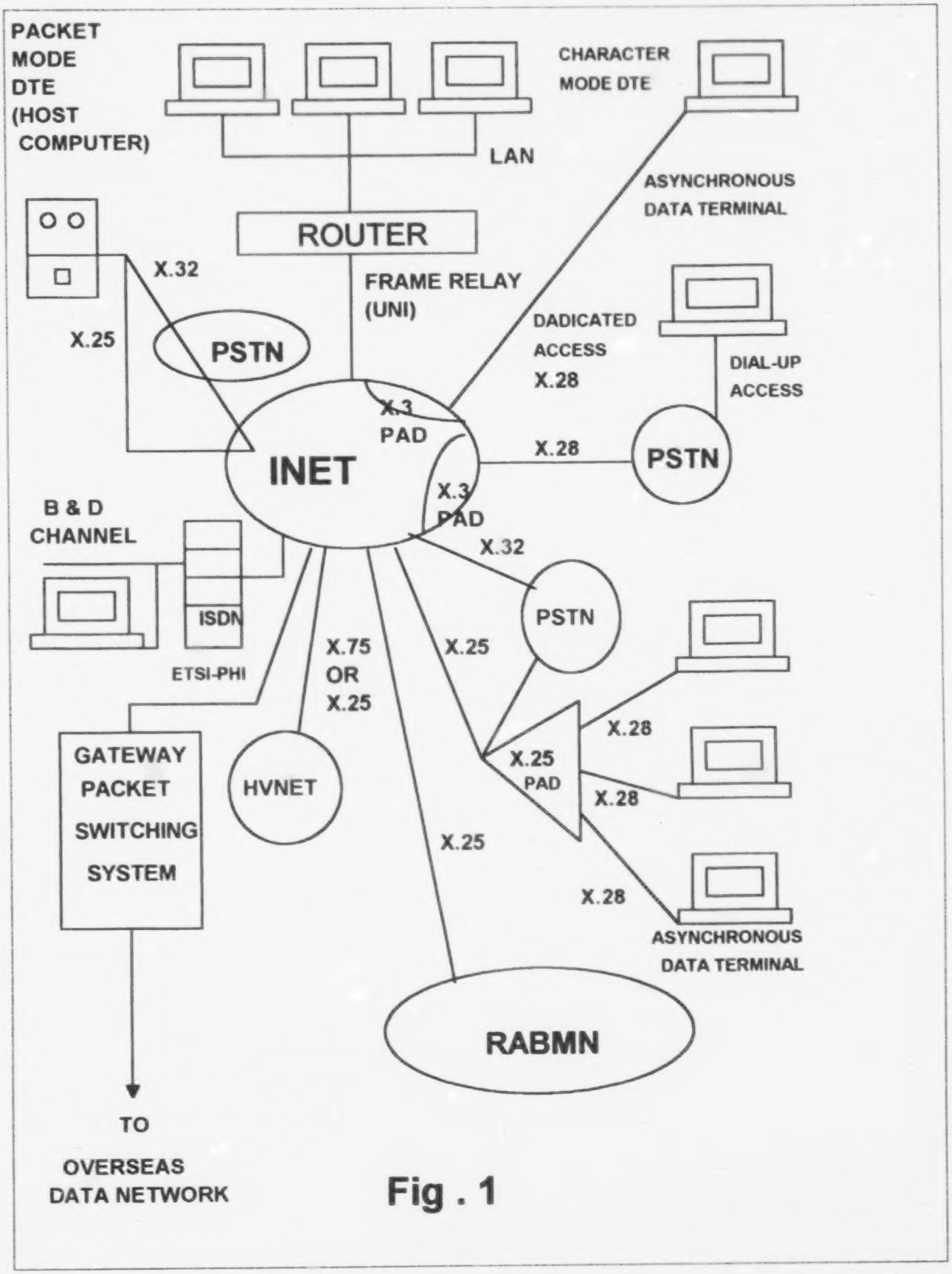

PACKET
MODE
DTE
(HOST
COMPUTER)
CHARACTER
MODE DTE
LAN
ASYNCHRONOUS
DATA TERMINAL
ROUTER
X.32
FRAME RELAY
(UNI)
DADICATED
ACCESS
X.28
X.25
PSTN
DIAL-UP
ACCESS
X.3
PAD
X.28
PSTN
INET
X.3
PAD
B & D
CHANNEL
X.32
PSTN
ISDN
ETSI-PHI
X.75
OR
X.25
X.25
X.28
GATEWAY
PACKET
SWITCHING
SYSTEM
HVNET
X.25
PAD
X.28
X.25
X.28
ASYNCHRONOUS
DATA TERMINAL
RABMN
TO
OVERSEAS
DATA NETWORK

Fig . 1

Voice Mail Service in Advanced Intelligent Network

Kwang-Jae Jeong, Tae-Il Kim and Go-Bong Choi
Electronics and Telecommunications Research Institute
161 Kajong-Dong, Yusong-Gu, Taejon, 305-350, KOREA
Tel : 82-42-860-4958, FAX : 82-42-860-6380, E-Mail : kjjeong@tdx.etri.re.kr

Abstract

Voice Mail Service(VMS) discussed in this paper, is not defined as Intelligent Network(IN) Capability Set(CS)-1 service. This paper defines VMS for the purpose of being provided as an Advanced IN(AIN) service, and deals with the corresponding IN architecture using Intelligent Peripheral(IP). Also, this paper addresses the service functions, and designs the message scenarios of authentication, message receiving, message sending, service profile registration, automatic answering and automatic message sending procedure. In case that the called party is busy or no answer, the calling party can dialogue indirectly by recording the voice messages through the automatic answering telephone of the terminating subscribers. However, if the called party has the plain telephone, the calling party has to wait for an unexpected time. Although the end-users are not equipped with the automatic answering telephone, they can send and receive the voice messages to the busy or no-answer subscribers using AIN VMS functions proposed in this paper. Implementation of AIN VMS using the message scenarios in AIN Service Switching Point(SSP) and IP is also discussed.

1. Introduction

The telecommunications industry has paid considerable attention during past several years to the concept of rapid deployment of new services in telecommunication networks through the use of IN technology. To meet rapidly evolving market demands and requests for customized service, ETRI has developed IN SSP, Service Control Point(SCP), and IP prototype to ensure competence of the major IN network elements for the effective deployment of target set of IN CS-1 services defined in International Telecommunications Union - Telecommunication standardization sector(ITU-T) Recommendation Q.1211. IP, one of the major components of IN infrastructure, provides a new generic interface for end-user interactions to implement network based services that cannot be easily provided by the traditional switching elements. New emerging technologies such as speech recognition and text-to-speech enable IP to provide the customized service for end-users.

IN CS-1 is the first standardized stage of evolution based upon the existing technology base and on evolvability requirements addressed in ITU-T Rec. Q.1211, Whereas IN CS-2, in other words, Advanced IN(AIN) is currently being studied by ITU-T, and has a service-independent platform where the various telecommunication services, service management services and service creation services can be provided. Also, ETRI is developing its new AIN to meet customer demands more quickly and economically.

Chapter 2 will describe the concept and architecture of IN. Also, network interfaces between IN elements such as SSP, SCP and IP will be mentioned in this chapter. Chapter 3 will define and detail VMS mentioned above. Chapter 4 will design VMS scenarios of the service functions. Chapter 5 will deal with how VMS is implemented in AIN, and discuss the relative merits of this AIN service.

2. The DFP Architecture of IN

Figure 1 shows the architecture of Distributed Functional Plane(DFP) in IN. The physical entities defined in the architecture are SCP, SSP, Service Creation Environment(SCE), Service Data Point(SDP), Service Management Point(SMP), IP, and Adjunct. The IN architecture as defined by ITU-T provides the following attributes.

- Signaling System No.7(SS7) is a core requirement for the IN that provides signaling connection(i.e. Message Transfer Part(MTP)/Signaling Connection Control Part(SCCP)/Transaction Capability Application Part(TCAP) & Intelligent Network Application Protocol(INAP) between the SCP and the SSP.
- SSP provides flexible network switching function such as Call Control Function (CCF) and Service Switching Function(SSF), supports extensive call triggers such as dialed number line trigger and

181

routing trigger. Also, SSP may support Call Control Agent Function(CCAF), Service Control Function (SCF), and Service Data Function(SDF).

- SCP provides centralized call processing and thus minimizes changes to the underlying switching infrastructure such as Local or Toll exchange.
- SMP is in charge of administering the data and service logic at SCP. It provides centralized management of multiple SCPs and may be connected to the IP.
- SCE is a powerful service creation tool that enables a service creator to modify(i.e. customize) and create new service quickly. The IP may have its own SCE.
- IP is used for dialogues between the user and the IN(i.e. SCP). IP supports the user-friendly User-to-Network Interface(UNI) and the Specialized Resource Function(SRF). SRF provides the following capabilities.
  - ✓ User interactive dialogue support to the IN SCP for processing of IN calls during IN dialogues.
  - ✓ Collection of user input such as voice input or Dual Tone Multi-Frequency(DTMF)
  - ✓ Playing customized and mass announcements
  - ✓ Basic errors handling such that play retry announcement and re-collect user input with control of SCP.
- SDP contains and manages service data required to provide IN services for service logic, and supports SDF.

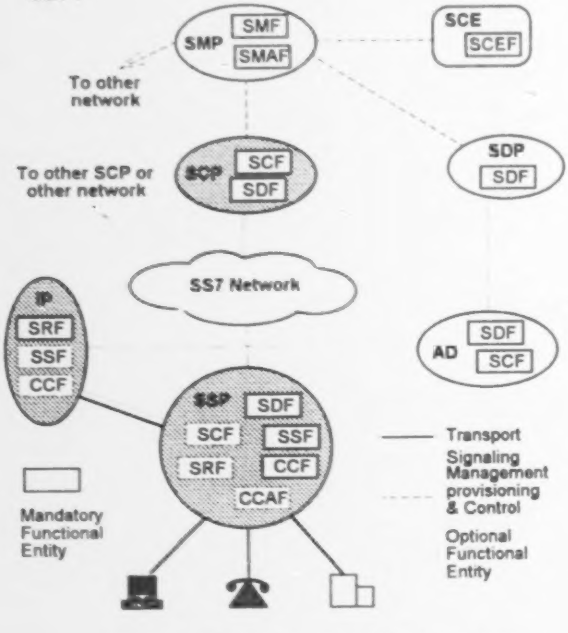


Figure 1 The IN Functional Architecture

SSP recognizes that the end-users request VMS, and notifies SCP to invoke the related Service Logic Program(SLP). Also, SSP relays between the end-users or SCP and IP, and provides the routing capability for IP. SCP provides the service logic and data related to service provision, and processes VMS under the control of service logic. IP preserves network resources such as announcements, speech recognition, text-to-speech and message receive or send related to service processing. Also, IP provides end-users with network resources based on SCP control via the SSP, and collects digits from the end-users. SMP is operated by network operator, and has the role of managing the data and service logic. SS7 Network transfers SS No.7 messages between SCP and SSP.

3. VMS

3.1 Definition and service functions

This paper defines AIN VMS not defined in ITU-T IN CS-1. VMS is defined as following.

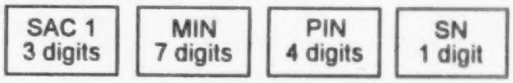
"VMS is message storage and transfer service provided by Network operator or service provider. VMS must support fundamentally that the service users record the voice messages into the mail box of subscribers and communicate with each other indirectly, when there is no telephone connection with the service subscribers. Also, VMS can support that the service users transfer the various type of messages included in voice, FAX, image, etc. Therefore VMS enables the service users to get the useful information easily and satisfy their various demands."

As described above, this paper defines VMS to be provided as AIN service, and proposes that VMS must provide service functions as following.

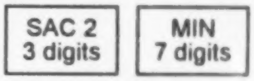
- Message mail(receiving & sending) function
- Pager and notification function
- AudioTex function
- Automatic answering function
- Automatic pager and notification function
- Automatic message-sending function

3.2 The numbering system

Subscribers have access to VMS through Service Access Code(SAC) with 3 digits, Mailbox Identification Number(MIN) with 7 digits, Password Identification Number(PIN) with 4 digits, and Selection Number(SN) with one digit. There are two SACs in order to isolate the service subscribers from the service users, as shown in figure 2. In case that the service subscriber dials SAC 1 and MIN, service logic requests him/her to enter PIN through announcements, and then he/she dials PIN. Then service logic determines if the PIN is valid. If valid, service logic provides VMS to the service subscriber and charge to the dialed MIN. In other case that the service user dials SAC 2, he/she can record the voice messages into the mail box of the service subscriber like the automatic answering telephone when the called party is busy and no-answer.


SAC 1
3 digits
MIN
7 digits
PIN
4 digits
SN
1 digit

(a) For service subscribers


SAC 2
3 digits
MIN
7 digits

(b) For service users

Figure 2 The numbering plan of VMS

4. The VMS scenarios

4.1 The general procedure

The general procedure of VMS, as shown in figure 3, consists of 7 procedures; authentication procedure, message-receiving procedure, message-sending procedure, service profile registration procedure, automatic answering procedure, automatic message-sending procedure, authentication retry procedure, etc. In case that the end-users dial SAC 1, they can access all service functions. However, in case of dialing SAC 2, the calling parties can access message-receiving and automatic answering procedure. If the users enter the digits unsuccessfully, they can re-try within the number of maximum re-try times. When the end-users exceed maximum re-retries, network clears the call through announcements. The subscribers, dialing SAC, MIN, and PIN correctly, can record their voice messages in the mailbox; then network sends these messages to the desired called party. Also, network notifies automatically that his/her mailbox received the messages.

4.2 The VMS Function procedures

This section describes the VMS function procedures using Information Flows(IFs) defined in ITU-T Rec. Q.1214. All messaging between SCP and SSP uses TCAP of SS7; SCP is connected to SSP over SS7 network. IP may exchange data with SCP while IP is connected to a user through SSP switch; all messaging is done through SSP switch. The interface protocol between SSP and IP is ISDN Q.931. Because there is no connection between SCP and IP, SSP provides inter-working between SCP and IP by appropriate protocol conversions.

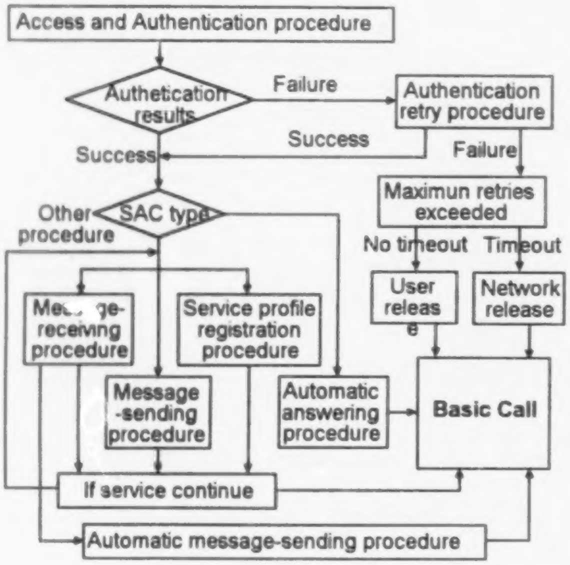

Access and Authentication procedure
Authetication results
Failure
Authentication retry procedure
Success
Success
Failure
Maximun retries exceeded
No timeout
Timeout
Other procedure
SAC type
User releas e
Network release
Message-receiving procedure
Service profile registration procedure
Message -sending procedure
Automatic answering procedure
Basic Call
If service continue
Automatic message-sending procedure

Figure 3 The general procedure of VMS

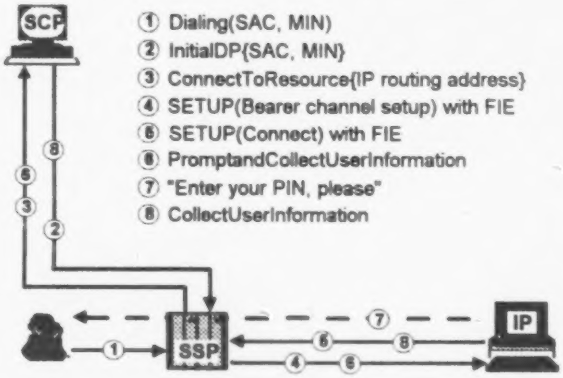

SCP
① Dialing(SAC, MIN)
② InitialDP{SAC, MIN}
③ ConnectToResource{IP routing address}
④ SETUP(Bearer channel setup) with FIE
⑤ SETUP(Connect) with FIE
⑥ PromptandCollectUserInformation
⑦ "Enter your PIN, please"
⑧ CollectUserInformation
⑥
③
⑧
②
①
SSP
⑦
⑥
⑧
④
⑤
IP

Figure 4 Authentication procedure

(1) Authentication procedure

SSP triggers on the basis of SAC dialed by the service user to access VMS, as shown in figure 3. The end-user, once connected to IP, enters MIN to record/listen into his/her voice messages or access/modify his/her service profile. Application process in SCP, SLP, determines if SAC, MIN and PIN are valid as authentication procedure shown in figure

4. If the collected digits are invalid, then the calling parties can retry authentication procedure as far as maximum retries exceeded.

(2) Message-Receiving Procedure

Only the user, who is already verified through authentication procedure, can select the message-receiving procedure. The access of the message-receiving procedure can be provided through announcements, DTMF digits or speech synthesis as shown in figure 5. The end-user can record his/her voice messages in mailbox through announcements or DTMF digits

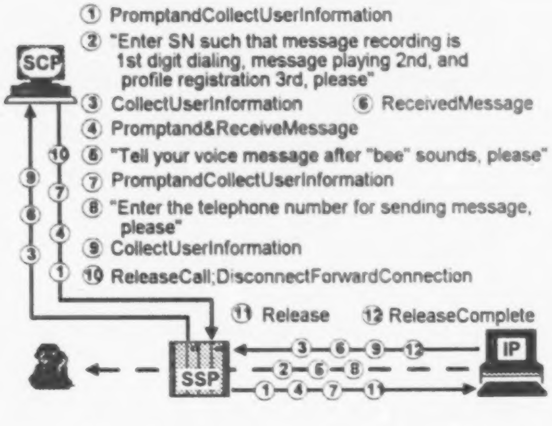

① PromptandCollectUserInformation
② "Enter SN such that message recording is 1st digit dialing, message playing 2nd, and profile registration 3rd, please"
③ CollectUserInformation
⑥ ReceivedMessage
④ Promptand&ReceiveMessage
⑤ "Tell your voice message after "bee" sounds, please"
⑦ PromptandCollectUserInformation
⑧ "Enter the telephone number for sending message, please"
⑨ CollectUserInformation
⑩ ReleaseCall;DisconnectForwardConnection
⑪ Release
⑫ ReleaseComplete
SCP
SSP
IP

Figure 5 Message-receiving procedure

(3) Message-Sending Procedure

Only the subscriber, passed through authentication procedure, can select the message-sending procedure. The access of the message-sending procedure can be provided through announcements, DTMF digits or speech synthesis as shown in figure 6. The end-user can listen to his/her voice messages in mailbox through announcements or DTMF digits. In case that the end-users did not subscribe to VMS, they can record their voice messages into the subscriber's mailbox; then VMS makes it possible to play these messages to the subscriber through message receiving procedure automatically or manually.

(4) Service Profile Registration Procedure

Only the subscriber, passed through authentication procedure, can select the service profile registration procedure. The access of the service profile registration information can be provided through announcements, DTMF digits, speech recognition, or speech synthesis, as shown in figure 7. The subscriber can modify his/her profile information such as automatic answer registration/deregistration, Automatic Message Sending Number(AMSN), multi-receiver number and MIN through announcements or DTMF digits.

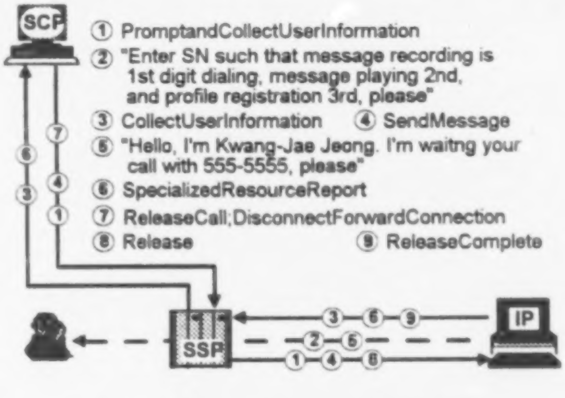

① PromptandCollectUserInformation
② "Enter SN such that message recording is 1st digit dialing, message playing 2nd, and profile registration 3rd, please"
③ CollectUserInformation
④ SendMessage
⑤ "Hello, I'm Kwang-Jae Jeong. I'm waitng your call with 555-5555, please"
⑥ SpecializedResourceReport
⑦ ReleaseCall;DisconnectForwardConnection
⑧ Release
⑨ ReleaseComplete
SCP
SSP
IP

Figure 6 Message-sending procedure

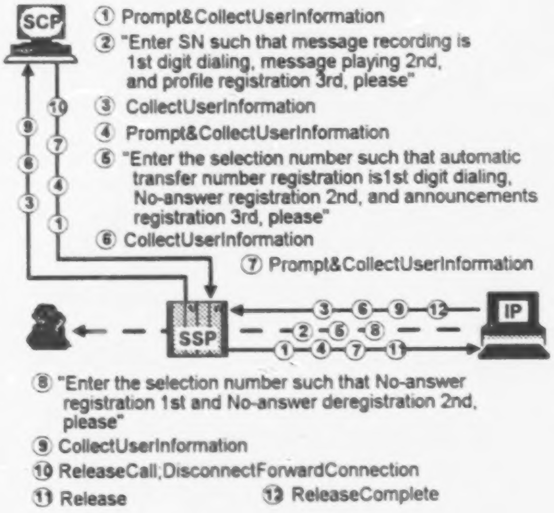

① Prompt&CollectUserInformation
② "Enter SN such that message recording is 1st digit dialing, message playing 2nd, and profile registration 3rd, please"
③ CollectUserInformation
④ Prompt&CollectUserInformation
⑤ "Enter the selection number such that automatic transfer number registration is1st digit dialing, No-answer registration 2nd, and announcements registration 3rd, please"
⑥ CollectUserInformation
⑦ Prompt&CollectUserInformation
SCP
SSP
IP
⑧ "Enter the selection number such that No-answer registration 1st and No-answer deregistration 2nd, please"
⑨ CollectUserInformation
⑩ ReleaseCall;DisconnectForwardConnection
⑪ Release
⑫ ReleaseComplete

Figure 7 Service profile registration procedure

(5) Automatic Answering Procedure

The end-user tries to call somebody, but he is not at home. In this case, there is no way to dialogue with each other. When the end-user want to dialogue with VMS subscriber who is out, VMS enables the users to record the voice messages into the mailbox of subscriber as if they record their voice messages to Telephone Attached Device(TAD) so called tape

184

recorder.

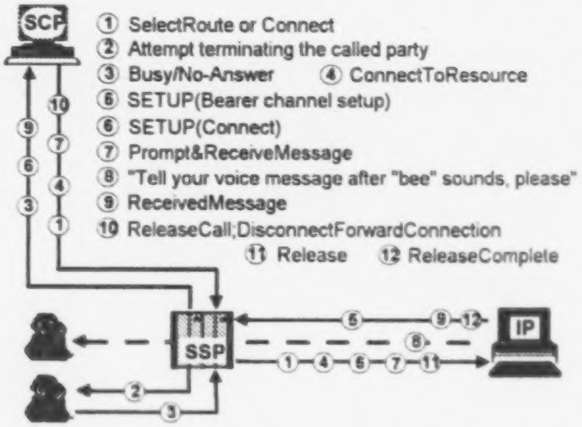

SCP
① SelectRoute or Connect
② Attempt terminating the called party
③ Busy/No-Answer
④ ConnectToResource
⑤ SETUP(Bearer channel setup)
⑥ SETUP(Connect)
⑦ Prompt&ReceiveMessage
⑧ "Tell your voice message after "bee" sounds, please"
⑨ ReceivedMessage
⑩ ReleaseCall;DisconnectForwardConnection
⑪ Release
⑫ ReleaseComplete
SSP
IP

Figure 8 Automatic answering procedure

Later, the service subscriber can listen to the voice message, recorded by the user, in his/her mailbox. Figure 8 shows automatic answering procedure enabled to mail the messages to the subscriber who is out. Like other procedure, automatic answering procedure can be provided through announcements and DTMF digits.

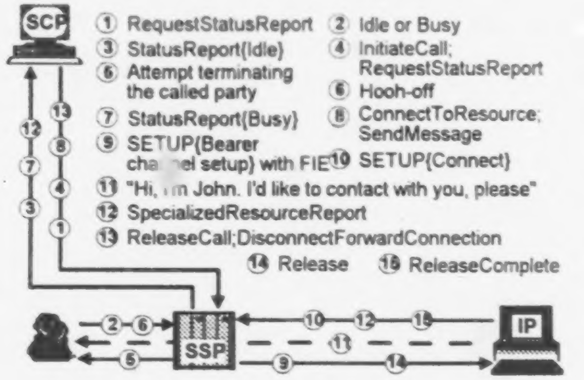

SCP
① RequestStatusReport
② Idle or Busy
③ StatusReport(Idle)
④ InitiateCall; RequestStatusReport
⑥ Attempt terminating the called party
⑥ Hooh-off
⑦ StatusReport(Busy)
⑧ ConnectToResource; SendMessage
⑨ SETUP(Bearer channel setup) with FIE
⑩ SETUP(Connect)
⑪ "Hi, I'm John. I'd like to contact with you, please"
⑫ SpecializedResourceReport
⑬ ReleaseCall;DisconnectForwardConnection
⑭ Release
⑮ ReleaseComplete
SSP
IP

Figure 9 Automatic message-sending procedure

(6) Automatic Message-Sending Procedure

As shown figure 9, automatic message-sending procedure sends the voice messages in the mailbox to VMS subscriber automatically. In case that the end-user records the messages into the mailbox of the subscriber and subscriber registers AMSN in his/her profile information, VMS sends these messages to the subscriber automatically. In other case that the subscriber records his/her message in his/her mailbox and registers multi-receiver in his/her service profile, VMS sends these messages to the end-user automatically. If VMS does not transfer these messages to the subscriber or users, then VMS tries to send repeatedly at intervals of 4 hours during 24 hours.

5. The implementation of VMS

5.1 System configuration

We implemented prototype systems of IP, SSP and SCP on the basis of network architecture and protocol as shown by figure 10. This paper proposes AIN VMS using AIN prototype systems. IP connects with SSP directly and SCP via SSP. SSP communicates with IP through ISDN user-network interface. ISDN UNI consists of D-channel and B-channel; D-channel for control information and B-channel for user information such as voice.

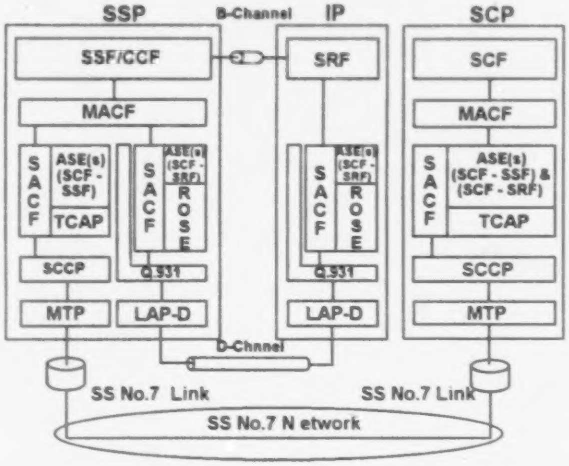

SSP
B-Channel
IP
SCP
SSF/CCF
SRF
SCF
MACF
MACF
SACF
ASE(s) (SCF - SSF)
TCAP
SACF
ASE(s) (SCF - SRF)
ROSE
SACF
ASE(s) (SCF - SRF)
ROSE
SACF
ASE(s) (SCF - SSF) & (SCF - SRF)
TCAP
SCCP
Q.931
Q.931
SCCP
MTP
LAP-D
LAP-D
MTP
D-Chnnel
SS No.7 Link
SS No.7 Link
SS No.7 N etwork

Figure 10 The AIN architecture for prototype systems

5.2 S/W form of AIN IP

As shown figure 11, the S/W forms of AIN IP classify 4 parts: Resource Control Part(RCP), Resource Function Part(RFP), Communication Part(CP), and Database Part(DP).

(1) Resource Control Part

RCP controls AIN IP and consists of Resource Manager(RM), Resource Logic Libraries(RLLs) and Resource Logic Instances(RLIs). RM as main process creates a new process to perform resource request from SCP; on receiving resource request message, RM determines if requested resource function is available. If available, RM creates RLI using related

RLL. When RLI is done, RM sends that results to SCP, and terminates RLI. Therefore, RM manages general procedure from creation to termination, and RLL is a set of procedures for performing resource functions.

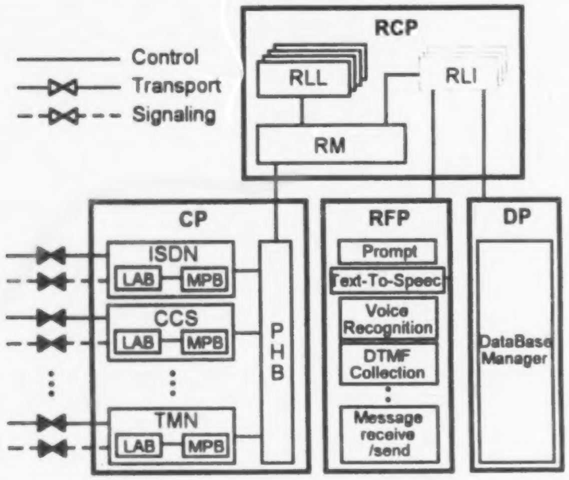


Figure 11 S/W form of AIN IP for VMS

(2) Communication Part

RFP plays the role of communication with physical FEs, and consists of Line Access Blocks(LABs), Message Processing Blocks(MPBs), and Protocol Handling Block(PHB). Since IP have to communicate with various networks such as Integrated Services Digital Network(ISDN), Common Channel Signaling(CCS) and Telecommunication Management Network(TMN), IP is necessary to Multi LABs and MPBs. LABs provide interface with external FEs, and MPB encode and decode for appropriate protocol. PHB change messages created by various protocols to primitives, and reversibly.

(3) Resource Function Part

RFP is a set of resource functions such as announcements, DTMF detection, DTMF collection, speech recognition, speech synthesis, message receive/send, etc. Generally A resource consists of one or more resource function.

(4) Database Part

DP consists of Database Manager(DM) and data such as speech, image, text, etc.

5.3 Implementation of VMS

We are implementing VMS on the basis of AIN prototype systems as shown in figure 10 and 11, through the design of message scenarios for VMS and service functions in chapter 3 and 4. SCP controls SSP and IP, and sends instruction messages such as PCUI, CTR, etc., through SLP for VMS. Also, SCP receives the responding messages for instruction messages from SSP and IP, and sends the next control message for service processing. VMS is provided through IP resources such as prompt resource, message receive/send, etc. When the caller requests VMS, SSP provides the flexible switch capability and IP offers network resources. This paper would like to confirm the possibility that VMS may be provided as the useful and user-friendly service, and AIN service.

5. Conclusion

This paper described VMS as an AIN service. VMS not defined as ITU-T IN CS-1 service, make it possible to increase call completion rate in public network. If the called party is no answer or busy, then VMS enables service users to leave the voice message in the mail box of AIN IP and to send this message to service subscribers. Therefore, VMS expects to increase information exchange between end users and to decrease call traffics. Also, VMS will increase the efficiency of network resource usage. However, there are problems with isolating the mail box for automatic answering from the tape recorder of the automatic answering telephone. These problems will have been studied for further.

Reference

[1] Ph. Chailey, M. Deroussen, M. Renault and A. Henry, "intelligent Peripheral Based on UNIX Application to voice services", ICIN'92, pp. 70-72, 1992.

[2] T. Morisawa, M. Sasaoka and H. Miyabe, "System Design for Voice Storage Service", ECL Tech. Jour., Jpn., Vol.32, No.6, pp. 995-1002, 1984.

[3] T. Isayama and T. Mochizuki, "Voice Storage Services", JTR Oct., pp. 271-280, 1986.

[4] S. Ng and R. Sells, "The Role of the Intelligent Network in the Network Services Enhancement and Interaction", APCC'93, pp. 97-99, 1993.

[5] M. Chopra, "Exploring Intelligent Peripheral Configurations", ICUPC'94, pp. 635-639, 1994.

[6] S. K. Jain, "Intelligent Peripheral: Signaling and Protocols", ISS'92, pp. 117-121, Oct., 1992.

[7] K. J. Jeong, T. I. Kim and G. B. Choi, "The

Design of Vloice Mail Service Scenario in Advanced Intelligent Network", JCCI'95, pp. 18-22, Apr., 1995.

[8] ITU-T Q.1211, "Introduction to Intelligent Network CS-1," 1994. 6

[9] ITU-T Q.1214, "Distributed Functional Plane for Intelligent Network CS-1," 1994. 6

[10] ITU-T Q.1218, "Interface Recommendation for Intelligent Network CS-1," 1994. 6

[11] G.B. Choi, H.H. Lee, Y.S. Kim, H.G. Bahk, TDX-10 SSP : A Service Switching Point for Intelligent Networks, ICEIC'91, Yanji, China, Aug. 19-23 1991, pp. II293-II296.

[12] G.B. Choi, H.H. Lee, Y.S. Kim, H.G. Bahk, A Service Switching Point for Intelligent Networks, ICCC'92, Tampa, U.S.A., May 4-6 1992, pp. 268-274.

[13] Y.H. Seo, G.B. Choi, C. K. Lee, H.G. Bahk, A design and Implementation of the IP in Korea, APSITT'93, Bangkok, Thailand, Nov. 11-12 1993.

[14] H.H. Lee, T.I. Kim, G.B. Choi, C.K. Lee, H.G. Bahk, Development of a SSP System for Intelligent Networks, INFOCOM'93, Bombay, India, Nov. 25-27 1993, pp. 117-140.

[15] R. Soh, H.G. Jeong, H.H. Lee, D.S. Park, IP-Based Interactive Voice Services in Advanced Networks, JTC-CSCC'94, Kongju, Korea, July 11-13 1994, pp. 902-907.

[16] H.J. Cho, K.H. Jang, H.H. Lee, D.J. Kim, Performance Analysis of AIN SSP Based on Switching System TDX-10, JC-CNSS'94, Taejon, Korea, July 13-15 1994, pp. 331-335.

[17] K.R. Kim, H.J. Lim, Y.G. Kang, H.H. Lee, Y.S. Kim, Experience in Prototyping the Service Switching Point for AIN, ICCS'94, Singapore, Nov. 14-18 1994, pp. 1144-1148.

[18] Y.H. Seo, G.B. Choi, C.M. Han, IP: Intelligent Peripheral for IN, ISITA'94, Sidney, Australia, Nov. 20-25 1994, pp. 531-534.

[19] K.R. Kim, H.J. Lim, M.S. Cho, H.H. Lee, T.I. Kim, G.B. Choi, IN Call Processing of the Service Switching Point, APCC'95, Japan, June 14-16 1995, pp. 108-112.

[20] Y.H. Seo, G.B. Choi, Design and Prototyping of Intelligent Peripheral for IN, MICC'95, Malaysia, Nov. 22 1995.

Intelligent SS7 Network Management with S7DM

Jingsha He, Ph.D., Yi-Shang Shen, Ph.D.(1), and Don Albright
MCI Telecommunications Corporation
Network Systems Engineering
2400 North Glenville Drive
Richardson, Texas 75082, USA

1. ABSTRACT

In this paper, we present the SS7 Data Manager (S7DM) which is under development by MCI to meet the company's need for intelligent SS7(2) network management. The primary goal of S7DM is to build a dynamic platform upon which pro-active and intelligent data management of the SS7 network can be accomplished. To achieve this goal, a problem/resolution library (PR library) is used in S7DM that acts as the system profile for keeping track of network problem events along with a list of known resolutions to the problems. This library serves as the foundation of S7DM for the implementation of an intelligent network management platform. First, it provides S7DM with intelligence or knowledge on past engineering and problem-solving experience that help identify network problems and predict future catastrophic network failures resulting from abnormal behavior of network elements. Second, it equips S7DM with the capability of learning or knowledge accumulation that enhances the level of intelligence in S7DM on SS7 network monitoring and problem resolution. These capabilities enable S7DM to grow with MCI towards the establishment of a sophisticated telecommunications network that provides more intelligent and advanced network services and a high degree of network reliability and availability at a minimal capital expenditure.

2. INTRODUCTION

Advances in telecommunications technology present a great challenge to service companies. On one hand, these companies have to continuously upgrade their network infrastructure to provide more services and to improve the quality of services. On the other hand, inter-operability of equipment in their network and between local exchange carriers (LECs) and inter-exchange carriers (IXCs) make the management of the signaling and the switching network a task with an unprecedented level of difficulty and complexity. Not only does an effective and efficient means of network management add to the assurance that the complex network runs as desired to achieve a high degree of reliability, availability and resource utilization, but it also contributes to the planning of future network growth based on the present working characteristics of various network elements.

Network management is generally concerned with five areas: fault, performance, configuration, accounting, and security. In reality, however, few systems and applications provide a full functionality that covers all the areas. Furthermore, few provide the flexibility to expand problem coverage as the network grows resulting from the addition of new network elements and the upgrade of existing network elements. There exists a gap in sophistication between networks in operation and network management systems that maintain the networks. Lack of effective and efficient network management costs telecommunications companies millions of dollars each year due to network failures that should have been prevented and detected early, due to unnecessary expenditures caused by poor network planning, and due to telecommunications fraud resulting from inadequate network security measures against internal and external attacks.

SS7 Data Manager (S7DM) intends to address the complex issue of building a flexible and dynamic platform that provides sophisticated network management functions. In the center of the S7DM lies the so-called problem/resolution library (PR library) that is the foundation for S7DM to respond to the ever-increasing needs of dynamic network management. S7DM is a client-server application that runs at the application layer of the OSI Reference Model [1]. That is, S7DM relies on the support of lower layer protocols such as TCP/IP to connect the server, the clients and the monitored network elements to transmit the real-time network data. Besides the PR library, the server also maintains a central database for the storage of collected network data. These data are necessary for network management and analysis to reach various network management decisions. S7DM shall take most of its

188

input data from SS7 network elements and store the data in the central database. S7DM shall also be connected to other legacy network management systems to help it achieve network management functions. These systems might have been specifically developed to perform limited functions in certain areas such as configuration and accounting management. Data that arrive at S7DM and those that have been previously collected and stored in the central database will be analyzed for discovering network problems, for reporting network performance statistics, and for unveiling potential security threats to the SS7 network. S7DM intends to be the foundation for a new generation of data management platforms where intelligent and advanced management functions and services can be implemented. These functions include, but are not limited to, network problem diagnosis, maintenance, intelligent message routing and rerouting, future network traffic and performance prediction, automatic network recovery and reconfiguration, and security control of network access and usage.

This paper is organized as follows. In the next section, we describe some example network problems and S7DM solutions. In Section 4, we present the S7DM hardware structure and software architecture, identify major S7DM components, discuss the architectural features of S7DM, and show how the PR library can help S7DM achieve intelligent and pro-active network management. In Section 5, we discuss some issues in the implementation of S7DM. Finally, we conclude this paper in Section 6 with discussion on some possible future development directions.

3. NETWORK MANAGEMENT PROBLEMS

Technological advances in telecommunications have greatly enhanced the level and the quality of services that are offered to consumers. However, the lack of hardware compatibility and software control and management results in a lot of run-time operational problems that can only be handled in real time by the network management system. Unfortunately, few such systems from equipment manufacturers and independent software vendors are flexible enough to be able to handle network problems that are not specified in the initial product design and manufacturing. If a problem that is discovered in real time is not in the specifications, it cannot be recognized and is simply ignored by the management system in most cases. The consequence could be devastating because it may directly threaten the reliability, availability and quality of services. Some typical examples of SS7 network problems that cannot be well handled by most SS7 network management systems are presented in this section for demonstration.

3.1. STP SOFTWARE UPGRADE

Signal transfer points (STPs) are made in pairs in the SS7 network to achieve high performance and a high level of reliability and availability. In normal situations, the mated STP pair share network processing load. However, if one of them fails, the other is capable of taking over the entire processing load for continued services at a degraded mode. During software upgrade in STPs, the mated STP configuration allows the new software load to be installed and field-tested in one STP with the other providing backup which assures that services will not be disrupted due to software bugs and problems in the new software load. Should a problem occur in the STP with the new software load, processing would be taken over by the mated STP with the present software load. This structure of STPs and the transition of services from one STP to the other is transparent to the users, however.

When an error occurs while STP software load is being changed because of errors in the new software, e.g., the missing of routing table entries causes signaling messages to be improperly routed, an alarm will be generated and the mated STP with the present software load will come forward and provide coverage for the troubled STP. To the rest of the SS7 network, the mated STP pair function correctly and the seriousness of the problem in the new STP software load can be shielded and therefore ignored. When the testing and transition phase is completed, the new software is also loaded into the mated STP to complete the software upgrade. It is only at this time does the problem in the new software load actually cause malfunctioning and interruption of network services, a catastrophe to users and to the reputation of the service company.

This problem along with the resolution can be documented in the PR library so the S7DM will be able to catch the alarm caused by the failure of operation in the STP with the new software load before it is applied to the mated STP.

3.2. SYSTEM INCOMPATIBILITY

Network elements (switches, SPs, STPs, etc.) that are manufactured by different vendors may not be fully compatible due to implementation limitations and the lack of a uniform interpretation of international standards. Neither are the network management systems developed for these network elements by the these vendors or other software companies. This incompatibility may causes network problems in the interactions between local exchange carrier (LEC) and inter-exchange carrier (IXC) equipment even if the carrier company might have developed a common specification across its own switching and signaling networks. Interactions between LECs and IXCs cannot be avoided because IXCs rely on LECs to complete calls and LECs rely on IXCs to reach out of their local access and transport areas (LATAs).

Due to the lack of full compatibility between network elements of LECs and IXCs, there exist instances where certain messages and alarms passed from, say, a LEC, to an IXC cannot be recognized by the management system of the IXC, and vice versa. These massages and alarms may indicate problems that originated in the network of the LEC and may affect the normal operations of the IXC. They may also indicate problems that have already existed in the network of the IXC but, nevertheless, have not been discovered by its network management system. Such messages and alarms are usually ignored if they cannot be recognized by the network management system, however. Typically, they result in the network elements in the LEC's network and in the IXC's network to reach inconsistent states. Such inconsistencies might be corrected by a synchronization function initiated by either side of the networks.

The problems along with the resolutions can be documented in the PR library so the S7DM is able to recognize the messages and alarms and to take necessary steps to resolve the problems. This capability would make these messages and alarms recognizable so that appropriate resolutions can be used to correct future occurrences of the same network problems.

3.3. PROCEDURAL DIFFERENCES

LECs handle requests from IXCs for received services. For example, IXCs may rely on LECs to collect phone bills long distance services. But each LEC handles such requests differently. Therefore, IXCs cannot expect LECs to respond uniformly to their requests. Since the same request from an IXC to different LECs may trigger different responses, the handling of the responses from different LECs may need to be dealt with differently. Furthermore, unilateral hardware and software upgrade in the LEC networks requires that the network management system of the IXCs be flexible enough in such a dynamic environment. For changes in the LEC network that may affect the normal operations in the IXC network, necessary adjustment to the PR library is all that is needed for S7DM to work in the new environment. This flexibility is necessary and important in any network management systems to ensure the continuity of services despite environment changes in the LECs that are beyond the control of the IXCs.

3.4. ALARM UNIFICATION

Most network management systems detect and report merely local network problems that are constrained by design specifications. When a network event occurs, multiple alarm messages may be generated and sent to the network management center. Moreover, more than one network element could be affected by this single event. Thus, this event may trigger all the affected elements to generate their own version of alarm messages to be sent to the network management center. These alarm messages fill up the management console quickly and are difficult for the support staff to correctly diagnose the problems. It becomes even more complicated if the affected elements are supplied by different manufacturers because the alarms generated by different elements for the identical event may not consistently convey the same nature of the problem. Therefore, a network management system must have the intelligence to analyze and filter out redundant alarm messages that result from the same network event and to recognize and unify alarm messages from different sources. This analysis should present to the support staff the accurate nature of the network problems as well as the proper actions for resolving the problems.

The PR library can support alarm message processing and unification. This is achieved by establishing a time frame for each message class and by aliasing the different messages that correspond to the same network event under a single class. Alarm messages of the same class that arrive at the network management center within the time frame will be treated as redundant messages for the same network event and will be ignored. The parameters that support these functions are dynamically established.

4. S7DM SYSTEM ARCHITECTURE

The key to achieve this objective relies on a flexible and dynamic system structure and software architecture and design that is the subject of this section.

4.1. COMPONENTS AND INTERCONNECTION

There are three types of nodes in S7DM interconnected through a private network. They are the *server node* or processing node, the *management node*, and the *monitor node*. A node in S7DM is a personal computer or a workstation that runs S7DM software to accomplish a distinguished set of tasks. These nodes also cooperate with each other to perform the desired network management functions. The three types of nodes as well as their interconnection structure is illustrated in Figure 1.

190

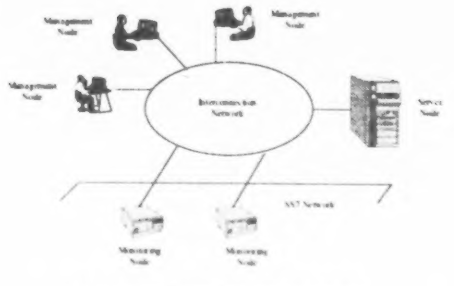


Figure 1. S7DM SYSTEM AND INTERCONNECTION STRUCTURE

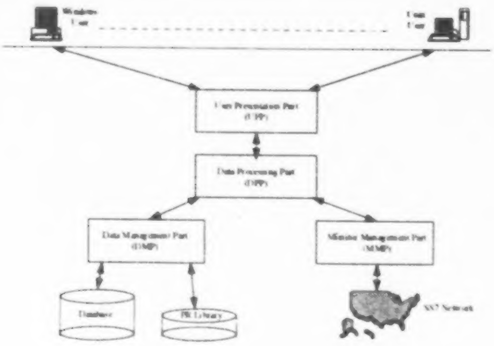

Windows User
Unix User
User Presentation Part (UPP)
Data Processing Part (DPP)
Data Management Part (DMP)
Monitor Management Part (MMP)
Database
PR Library
SS7 Network

Figure 2. S7DM SOFTWARE SYSTEM STRUCTURE

The server node maintains a central database to store all the data received from the monitor nodes. It also maintains the PR library where monitored network problem events are documented along with resolutions to the problems if available. The PR library is logically separate from the central database. Technically, it is not a problem to combine the PR library with the central database. For performance reasons, however, such a separation would allow the storage and retrieval of problems and resolutions to be performed much faster because the PR library is a relatively small database. Other than maintaining the databases, the server node is also the place where most of the data processing takes place. They include, but are not limited to, database queries, alarm data and performance report collection and processing, problem resolution initiation and dispatching, system configuration and maintenance, and system administration.

There are a number of active client nodes called management nodes in S7DM. Management nodes are the interface of system administrators and support staff to S7DM. The functions of the S7DM system administrator include system and database installation, configuration and maintenance, user account management, event monitoring, and problem resolution and validation, etc. The role of the S7DM support staff is to operate the S7DM to support and maintain the SS7 network. Note that the server node can also be a management node. This makes the server machine both a database server and a database client for the S7DM system administrator as well as for the S7DM support staff members.

There are a number of passive client nodes called monitor nodes in S7DM. The monitor nodes are typically personal computers or workstations installed at network elements in the SS7 network to monitor problems and traffic into and out of the elements and to forward alarm and performance data generated in correspondence to problems and traffic in the SS7 network to the S7DM server for storage and processing. These nodes can be dynamically configured by the S7DM system administrator for collecting, filtering, and forwarding specified alarms and performance data to the S7DM server.

4.2. SOFTWARE ARCHITECTURE

The S7DM software structure is depicted in Figure 2 which consists of four major functional components. The *User Presentation Part* (UPP) interfaces the users, i.e., the S7DM system administrator, the SS7 support staff and the regular users, to the database server and to the monitor nodes. The main functionality of UPP includes the presentation of various alarm and reports to the users and the interpretation of user requests to direct database and network operations. The UPP software is running on the management nodes and on the server machine and can be tailored to suit different execution environments, e.g., Windows(3), X-windows, DOS, etc., for managing and supporting S7DM and the SS7 network. It is also the interface for the S7DM system administrator to administer and configure the individual components of S7DM.

The *Data Processing Part* (DPP) is the most important component of S7DM for its data processing and decision making capabilities. In addition to receive, process and dispatch data from the SS7 network, DPP also employs an inference engine that uses the rules in the PR library to reach resolutions for reported network problems. The inference engine is the brain of S7DM while the PR library supplies the knowledge for intelligent pro-active network management. The DPP software is running on the server machine to serve user requests from the S7DM system administrator, the S7DM support staff and the regular users.

The *Database Management Part* (DMP) manages the database where all the data for managing the SS7 network is stored. It also manages the PR library where network problems and events monitored by S7DM and their resolutions are stored. These include the handling of all requests from the DPP and from the Monitor Management Part (MMP). DMP provides the only means through which other components of the S7DM access the S7DM database and the PR library. The DMP resides on the server machine along with the central database and the PR library.

The *Monitor Management Part* (MMP) carries out the actual monitoring functions for S7DM at the network elements to collect specified network data. After limited processing and filtering, MMP sends the data to the server machine for storage and processing. When the data arrive at DPP, they will be processed and destined to various components of S7DM. If the data that arrive at the DPP indicate that an alarm has been raised in some network elements, the PR library will be consulted for resolutions and the alarm along with the resolutions will be forwarded to the designated management node to inform the S7DM support staff of the problems and the resolutions to the problem. The alarm data will also be saved in the central database and in the PR library for knowledge accumulation. If the data are regular traffic report, they will be directly stored in the central database for periodic processing by the DPP to generate performance reports to the S7DM support staff.

The advantages of structuring the software system of S7DM in the way illustrated in Figure 2 are as follows:

(1) This software organization identifies the individual components that can be developed in parallel by different groups of engineers or vendors. These components can then be integrated together with well-defined interfaces.

(2) This software organization allows readily available system development tools to be used for the implementation of each component. This would greatly reduce the total effort and the length of time needed for S7DM implementation.

(3) This software organization identifies the Data Processing Part (DPP) as the center of S7DM where all data processing and intelligent decision making functions are implemented. On the other hand, the level of sophistication of DPP would not in any way affect the correct functioning of the other software components of S7DM. Therefore, future evolution of the DPP towards higher degrees of sophistication and intelligence would be a smooth process.

4.3. THE PR LIBRARY

The problem/resolution library (the PR library) is the foundation for the implementation of pro-active and intelligent network management in S7DM. It stores and supplies the knowledge to the inference engine to derive resolutions to alarms and network problems, to predict future network problems and performance bottleneck based on present network behaviors, and to reach other conclusions for network management purposes.

The knowledge in the PR library is represented in the form of rules that are dynamically controlled for addition, modification and deletion. New knowledge on resolving network problems is entered into the PR library as new rules to augment existing resolutions and conclusions. Conflicts with existing rules will be flagged and resolved by S7DM support staff based on statistical and analytical data and based on past experience.

There are two types of rules in the PR library: fact rules and deduction rules. A fact rule conveys a fact: a conclusion or a resolution. Fact rules represent the ultimate knowledge for resolving known problems and reaching definite conclusions. A deduction rule expresses a relationship between various network events for the purpose of reaching final conclusions. Deduction rules represent logic and intelligence for resolving complex problems or deriving implicit natures of problems. Problem resolution usually starts with a deduction rule and ends with fact rules unless the problem is straightforward and resolutions are known and documented in the PR library as fact rules. This process creates a search tree with the initial problem deduction rule at the top and with the fact rules as the leaves. Therefore, heuristic search methods can be employed in the inference engine to minimize the average length of time needed for problem resolution.

4.4. MAJOR S7DM ACTIVITIES

The following major activities inside S7DM are identified:

(1) S7DM installation and configuration by the S7DM system administrator.

- The installation procedure shall be uniform across the entire platform of S7DM. This requires that the procedure prompt for the type of node that the current installation and configuration, load only the applicable set of modules and components, and run the necessary configuration steps.
- Configuration of S7DM includes the establishment of user profiles and the assignment of appropriate roles and access privileges to the users. User access

privileges are confined to the individual node machine where the privileges are clearly defined. Therefore, a user can be an S7DM support staff member on one management node but only a regular user on another. The establishment of network-wide roles and access privileges for users becomes feasible and its trustworthiness can be justified only after proper network authentication and authorization mechanisms are implemented.

- Configuration of S7DM also includes the establishment of the initial PR library on the server machine. The initial PR library may contain only those events that are derived from the specification for the monitor nodes. It could also contain other problem events that have been detected during daily network operations or discovered via special network configuration testing.
- Furthermore, the central database is initialized; that is, the schema of the database is defined although the database itself may not contain any meaningful data from the monitor nodes.

(2) Network event monitoring.

- The PR library serves as the profile for dynamic network problem and event monitoring.
- After initial configuration, subsequent events to be monitored are entered into the PR library by the S7DM support staff but need to be validated by the S7DM system administrator before monitoring of these events can take place in the monitor nodes.
- Alarms previously not in the PR library, thus are not currently supported by S7DM but, nevertheless, have arrived at the monitor nodes, can be transmitted to the server node for storage and processing and to designated management nodes. After thorough analyses, these alarms can be entered into the PR library along with possible ways of resolving the corresponding problems. Afterwards, pro-active monitoring of these events can be carried out at the monitor nodes.

(3) Alarm generation and reporting.

- An alarm that arrives at the monitor nodes should be transmitted to the server machine.
- After being processed by the Data Processing Part (DPP) of S7DM, the alarm will be forwarded to an S7DM support staff member or a group of members at a management node who is assigned the responsibility of resolving the corresponding network problems.
- The S7DM support staff member will be provided with a list of resolutions to the problems. These resolutions are derived from the PR library to aid the S7DM support staff member in the resolution of the problems.
- S7DM will also try to resolve the corresponding network problems corresponding automatically if the PR library rules indicate that the resolutions can be initiated automatically without human intervention. Typical such problems can be fixed by re-synchronizing or resetting network elements by automatically initiating the proper procedure. In this case, a report will be generated and sent to the S7DM support staff to record the activity. The level of such automation depends on many factors, among which are the level of sophistication of S7DM and the level of complexity of the problems and their resolutions, which is beyond the scope of this paper.

(4) PR library update.

- After a problem is resolved either automatically by S7DM or manually by a field engineer, a report is filed with the responsible S7DM support staff member who in turn will be responsible for entering the resolution into the PR library, a process of knowledge accumulation and intelligence enhancement in S7DM.
- However, the updated PR library needs to be validated by the S7DM system administrator before it can be used for future pro-active event monitoring at the monitor nodes.

(5) Regular users can log into S7DM, issue queries for alarm data and performance reports, and communicate with the S7DM system administrator and support staff for additional services such as the monitoring of new network events of their interests and responsibilities. In return, these users may be charged for the functions and services that S7DM is requested to provide to them.

4.5. ARCHITECTURAL FEATURES

The most noticeable feature of S7DM is its flexibility and scalability to support and monitor a large number of network events. This is achieved through the use of the PR library as the dynamic system configuration profile for the specification of network events to be monitored and documented. Network problems that have already been documented in the PR library help speed up the resolution process by offering possible causes and resolutions to the problems. Network problems that do not exist in the PR library will be recorded in the PR library along with resolutions to the problems that are entered by network engineers based on actual resolution experience. The PR library relieves network management from relying on human knowledge to resolve every instance of a problem through automating the resolution-finding process. This is especially important if human intervention to resolve problems can be completely replaced by automatic start of certain defined procedures. This is especially feasible whenever reconfiguration of certain network elements is all that is needed to resolve a problem or to respond to poor network performance.

To support a flexible and scaleable network management system like S7DM, the monitoring component must be able to be dynamically configured so that all alarms that have been raised in the monitored network elements will be sent to the S7DM server machine, even they are not in the initial specification of the monitoring component. This requires that the monitoring component allow dynamic configuration as to what events need to be monitored along with the criteria or threshold values to filter alarms and events and to send them to the S7DM server machine. Furthermore, this dynamic configuration should allow the use of wide card characters and strings to cover a wider range of network events than those that have been known and specified.

5. S7DM IMPLEMENTATION

The development of S7DM requires the determination of a general network management system as the platform on which various functions of S7DM can be implemented. This general network management platform should be based on the open systems technology, support major database management system (DBMS), and have a large number of network management applications available. The key towards the successful implementation of S7DM then relies on the identification of such a DBMS as well as various network management applications software that meet the requirements and specifications of S7DM. It also relies on the integration of the DBMS and the applications software. This approach allows us to take advantage of the state-of-the-art technology in network management, database development and applications, and artificial intelligence. It also provides S7DM with the flexibility to dynamically grow with technological advances in network management and to easily adapt to new operations environments as the needs arise and as management requirements change. Should additional network management applications be identified that is able to provide the desired functions required by S7DM, these applications could be easily integrated into S7DM.

S7DM shall be a client-server network management application. The server machine is responsible for the management of the central database where network data are stored and for that of the PR library where network events along with their resolutions are documented. The server machine is also responsible for the processing of user requests to access data and that of the alarm data sent from the SS7 network elements. In addition, the S7DM system administrator performs network configuration functions and user account management functions from the server machine. With sophisticated network authentication and authorization mechanisms, these configuration and management functions can also be carried out from client machines, however. The client machines generally carry out functions that interface S7DM to various users and to the SS7 network. The advent of the distributed database technology for achieving a high degree of reliability and availability will eventually make the distinction between server machines and client machines less significantly. The roles of the various users of the system, i.e., the S7DM system administrator, the S7DM support staff and the regular users, will remain the same. This evolution process should be seamless and should not in any way affect the normal operations of S7DM, however.

The DBMS in S7DM should be based on the client-server architecture and be able to support applications that process a large amount of data. It should also have a wide base of network management applications that can be readily integrated together to provide S7DM with desired SS7 network management functions. The DBMS will fulfill the functionality specified for the database management part (DMP) in the S7DM software architecture to manage the central database and the PR library. All requests to store and to access the data must be made through the DBMS interfaces. The DBMS will mostly run on the server machine where the central database and the PR library reside. Depending on how other network management applications are integrated and interact with it, the DBMS may need to have its client modules run on client machines to provide users with the means of accessing the database data. In this case, client software needs to be acquired as part of the User Presentation Part (UPP) and that of the Data Processing Part (DPP). The applications themselves should provide a unified interface for accessing the DBMS.

The Data Processing Part (DPP) of S7DM will be comprised of a set of applications that perform various network management functions specified in the S7DM requirements. One of the most important among them is the alarm collection and processing application that takes input data from the monitor nodes as well as any other sources that feed useful information into S7DM, processes the data to reach conclusions regarding network problems and resolutions, and generates desired reports on these problems and resolutions as well as reports on system performance statistics, network security threats, etc. These applications fulfill the functionality under the DPP and the UPP. They also work closely with the DMP for storing data into and retrieving data from the central database and for making use of the rules and knowledge in the PR library to perform intelligent data processing and analysis. These applications need to be integrated well with the Monitor Management Part (MMP) to receive data from the monitor nodes where S7DM can retrieve information to perform the desired tasks.

Finally, the Monitor Management Part (MMP) software is primarily responsible for the collection of data from the monitor nodes and for the transmission of the data to the DPP that runs on the server machine.

6. CONCLUSIONS

We described various aspects of S7DM including network management problems that S7DM intends to resolve. The key to achieve its objectives is the development of a flexible and dynamic network management platform which in turn is achieved through the PR library. The S7DM hardware and structure is described and the software architecture is presented and illustrated by the decomposition of S7DM into functional components during analysis and design and by the integration of the components during development and implementation. We also discussed some S7DM system implementation issues as to how individual components of the S7DM software system can be obtained or developed to provide an integrated set of network management functions.

Although the present S7DM development centers primarily around fault and performance management of the MCI's SS7 network, additional management functions can be similarly identified, developed, and integrated into S7DM to achieve other functionality in the areas of configuration management, accounting management, and security management. For configuration management and accounting management, adequate network-wide policies have to be established and used against the data that are collected from the SS7 networks during analysis. For security management, in addition to network-wide security policies regarding authentication and authorization, appropriate software mechanisms may be implemented to enforce these policies. Security mechanisms that correctly implement the authentication and authorization policies also help the S7DM perform its management functions in general. For example, proper network authentication enables the S7DM system administrator to perform its duties from any machine that is mostly convenient. This eliminates the requirement that such administrative functions be done through the dedicated server machine. Network authentication as well as network-wide authorization mechanisms can also be used to guard against internal and external threats that are the causes to telecommunications fraud and the millions of dollars in lost revenues each year to service companies.

The capability of S7DM's functional extension to include additional and advanced network management functions rests on the open systems technology on which S7DM development is being carried out. Because of the flexibility of as well as a wide support to the open systems technology, S7DM can continuously evolve even after deployment. Not only does this evolution add new network management functions into S7DM as the ever-changing needs of MCI's dynamic network environment, it also involves the identification and integration into S7DM of internal and external data sources that are determined to be useful in accomplishing various network management functions. As more and more functions are identified and implemented into it, S7DM will gradually become a multipurpose software system and a development platform on which various other network functions are implemented as long as they can benefit from the functionality offered by the base S7DM. This feature of S7DM is even attractive and can be supported by the use of the PR library in the S7DM architectural design because this library constitutes the brain of an intelligent base for S7DM that is able to accumulate more and more knowledge over time and may find the knowledge to be equally useful in various other network applications.

NOTES

(1) This author's address is MCI Telecommunications Corporation, 8003 Westpark Drive, McLean, VA 22102, USA.

(2) S7DM supports both ANSI and ITU-T versions of the SS7 protocols.

(3) Windows is a registered trademark of Microsoft Corporation.

REFERENCES

[1] *Information Technology - Open Systems Interconnection - Basic Reference Model: The Basic Model*, ISO/IEC 7498-1, 1994.

A Study on the DFP Architecture for Terminal Mobility: Design of the Terminal Access State Model

Ki Ryeung Kim°, Tae Il Kim, and Go Bong Choi

Electronics and Telecommunications Research Institute
161 Kajong-Dong, Yusong-Gu, Taejon, 305-350, KOREA
Tel: +82-42-860-4930, Fax: +82-42-860-6380, E-mail:krkim@nice.etri.re.kr

Abstract

This paper proposes the Terminal Access State Model that is a high-level description of the Call/connection related Radio Access Control Function activities required to establish and maintain a terminal access between a mobile terminal and the network. We add two Point In Calls and one Detection Point to the ITU-T Terminal Access State Model, and defines entry and exit events on the new Point In Call. The proposed model provides Call/connection related Radio Access Control Function activities required to process the handover feature.

I. Introduction

The Intelligent Network Capability Set-1(IN CS-1) was recently standardized in the International Telecommunication Union - Telecommunication standardization sector(ITU-T). Since the development of the IN CS-1 focused mainly on fixed network applications, the IN CS-1 was not able to support terminal mobility service features. Terminal mobility supports a wireless link between the user's mobile terminal and fixed network access points to provide freedom of movement for the user during the use of telecommunication services.

To provide terminal mobility services, the Intelligent Network Capability Set-2(IN CS-2) defined initial Distributed Functional Plane(DFP) architecture that includes new functional entities(FEs) such as Radio Access Control Function (RACF) and Radio Link Function(RLF). The RACF provides "call/ connection related" functions to manage a radio link(for example, terminal paging and radio link setup that consists of the allocation of network resources to support the radio link during call origination, delivery and handover). Also, it provides "non-call/connection related" functions (for example, terminal registration, terminal authentication) that are associated with neither call nor bearer connection. The RLF assists in providing network access to user. It is the interface between the user and the call /connection related functions (for example, radio frequency transmission and reception) as well as the interface between the user and non-call/connection related functions[1].

The initial architecture enhanced to support the various regional proposals as well as envisioned implementations. In the proposed enhancements, the RACF separates into Call/connection related Radio Access Control Function(CRACF) and Non-call/connection related Radio Access Control Function(NRACF)[2].

In this paper, we deal with CRACF and Terminal Access State Model(TASM). The TASM is a high-level description of the CRACF activities required to establish and maintain a terminal access between a mobile terminal and the network. At the ITU-T Q.6/11 meeting in Berlin, a Terminal Access State Model(TASM) was discussed and was included in draft Q.1224[3]. To support handover, this paper proposes redefined the TASM and descriptions of the states on the model. It provides CRACF activities required to process a handover feature and clarifies entry and exit events of each state.

II. Overview of the IN CS-2 DFP Architecture For Terminal Mobility

2.1. IN CS-2 DFP Modeling

The RACF contains two categories of functionality, call/connection related and non-call /connection related functionality. Due to the diverse nature of the call/connection related and non-call /connection related aspects of the RACF, it is possible that these functions are implemented on the different platforms. Therefore the initial IN CS-2 DFP architecture should accommodate such implementations. Figure 1 illustrates a refinement of the IN CS-2 DFP architecture. This architecture is refined as follows.

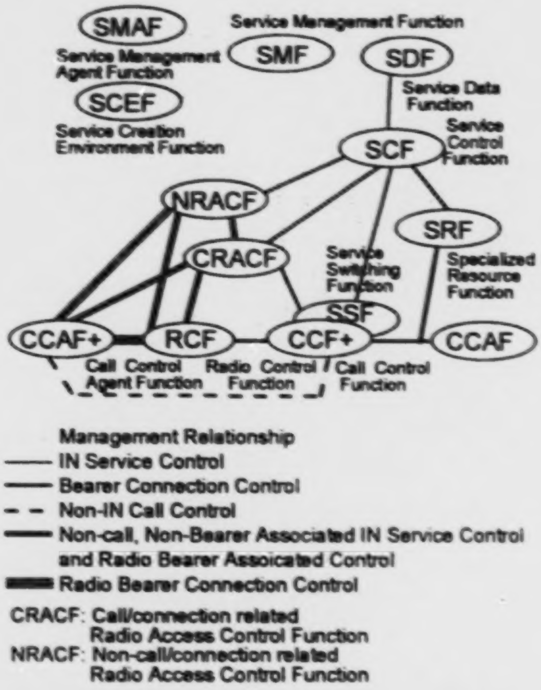

SMAF
Service Management Agent Function
Service Management Function
SMF
SDF
Service Data Function
SCEF
Service Creation Environment Function
SCF
Service Control Function
NRACF
SRF
CRACF
Service Switching Function
Specialized Resource Function
SSF
CCAF+
RCF
CCF+
CCAF
Call Control Agent Function
Radio Control Function
Call Control Function
Management Relationship
IN Service Control
Bearer Connection Control
Non-IN Call Control
Non-call, Non-Bearer Associated IN Service Control and Radio Bearer Assoicated Control
Radio Bearer Connection Control
CRACF: Call/connection related Radio Access Control Function
NRACF: Non-call/connection related Radio Access Control Function

Figure 1. IN CS-2 DFP for Terminal Mobility

(1) The RACF splits into two separate FEs, Call /connection related Radio Access Control Function(CRACF) and Non-call/connection related Radio Access Control Function(NRACF).

(2) Enhancements to the Call Control Agent Function (CCAF) and Call Control Function(CCF) for wireless access have been indicated by the "+" notation added to the acronym, CCAF+ and CCF+. Therefore, it is appropriate for the CCAF+ to represent the functionality indicated by the RLF, the accommodated architecture consolidates two FEs into CCAF+.

(3) The RACF may possibly be located in other network elements than the Radio System(RS). In such a case, RS would still contain network functionality but such functionality was not adequately reflected in the functional architecture. Therefore, an additional FE, Radio Control Function(RCF), is added to the initial IN CS-2 DFP architecture.

2.2 Terminal Mobility Service Features

In the mobile networks, the following mobile specific control concerning to connection handling are generally needed; (1) mobile call origination and termination, (2) routing to the mobile terminal, (3) terminal paging, and (4) handover.

Mobile call origination is a feature by which a user can make an outgoing call from any terminal. Mobile call termination is a feature by which incoming calls to a user are presented at the terminal address registered previously by the user. Routing enables a call to be routed to a switch controlling a cell where a called mobile terminal locates, according to the terminal location information. Terminal paging is invoked when a call is terminated to the mobile terminal to determine the radio zone where terminal locates and to establish the bearer connection to the terminal[4].

Figure 2 shows example scenario for mobile call origination and termination on the IN CS-2 DFP architecture.

① When a mobile terminal attempts a call setup with the network, RCF establishes a wireless bearer connection between the mobile terminal and network and sends Terminal Access Attempted event to the CRACF.

② If the Service Control Function(SCF) accepts the access of the mobile terminal to the network, then CRACF requests RCF to establish wire bearer connection.

③ The RCF establishes wire bearer connection, and adapts wire bearer to the corresponding wireless bearer.

④ The SSF/CCF sends InitialDP operation to the SCF to invoke IN service logic.

⑤ The SCF instructs the CRACF in the location registration area of the terminating mobile terminal to execute terminal paging.

⑥ If the CRACF receives a terminal paging response from the terminating mobile terminal, it returns the response to the SCF.

⑦ The SCF determines the final routing information and sends Connect operation to the SSF/CCF.

⑧ The SSF/CCF connects originating mobile terminal to the terminating mobile terminal.

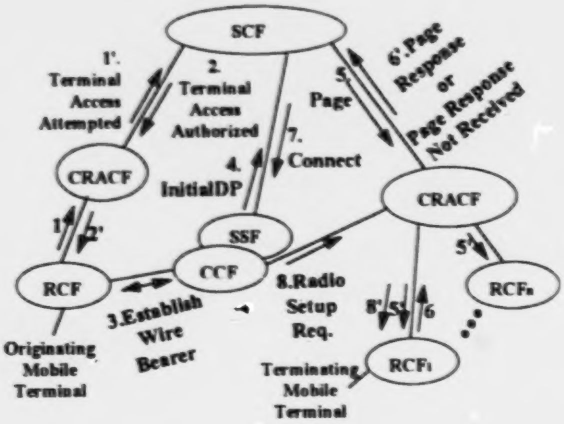
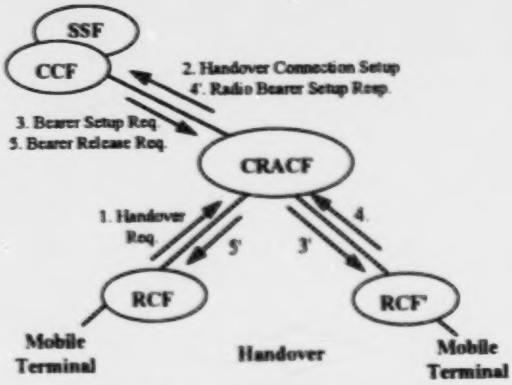

SCF
1'. Terminal Access Attempted
2. Terminal Access Authorized
5. Page
6'.Page Response or Page Response Not Received
CRACF
4. InitialDP
7. Connect
CRACF
1'
2'
SSF
CCF
RCF
5'
RCFn
3.Establish Wire Bearer
8.Radio Setup Req.
8'
5'
6
Originating Mobile Terminal
Terminating Mobile Terminal
RCF1

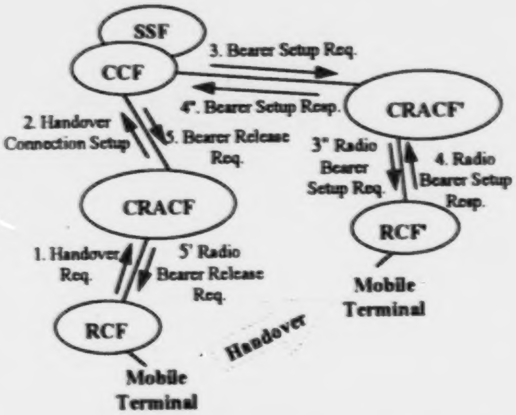
Figure 2. Mobile Call Origination and Termination

Handover occur when a mobile terminal moves from one radio zone to another radio zone during communication. This paper considers three scenarios of handover as shown in Figure 3[5].

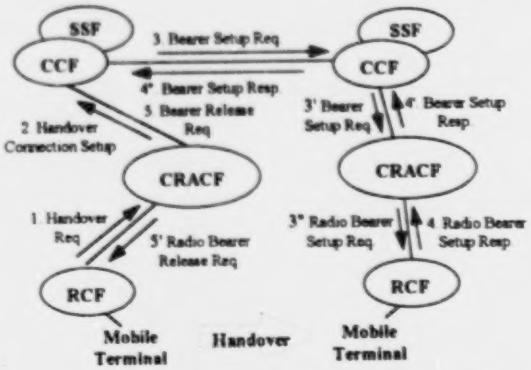
In scenario 1, new radio resources are selected under a RCF that is different from the one that controls the existing radio bearer while the RCFs are controlled by the same CRACF. In scenario 2, new radio resources are selected under a RCF that is different from the one that controls the existing radio bearer while the RCFs are controlled by different CRACFs(but under the control of the same SSF/CCF). In scenario 3, new radio resources are selected under a RCF that is different from the one that controls the existing radio bearer while the RCFs are controlled by different CRACFs, each of which is under the control of different SSF/CCF.


SSF
CCF
2. Handover Connection Setup
4'. Radio Bearer Setup Resp.
3. Bearer Setup Req.
5. Bearer Release Req.
CRACF
1. Handover Req.
5'
3'
4.
RCF
RCF'
Mobile Terminal
Handover
Mobile Terminal

Scenario 1. Controlled by the same CRACF


SSF
CCF
3. Bearer Setup Req.
4". Bearer Setup Resp.
CRACF'
2. Handover Connection Setup
5. Bearer Release Req.
3" Radio Bearer Setup Req.
4. Radio Bearer Setup Resp.
CRACF
RCF'
1. Handover Req.
5' Radio Bearer Release Req.
Mobile Terminal
RCF
Handover
Mobile Terminal

Scenario 2. Controlled by the different CRACF which is under the control of the same SSF/CCF


SSF
CCF
3. Bearer Setup Req
SSF
CCF
4" Bearer Setup Resp
5. Bearer Release Req
3' Bearer Setup Req
4' Bearer Setup Resp
2. Handover Connection Setup
CRACF
CRACF
1. Handover Req
5' Radio Bearer Release Req
3" Radio Bearer Setup Req
4. Radio Bearer Setup Resp
RCF
RCF
Mobile Terminal
Handover
Mobile Terminal

Scenario 3. Controlled by the different SSF/CCF

Figure 3. Information Flows for Handover

III. A Proposed TASM for Handover

The TASM identifies a set of call/connection related activities in the CRACF. Main concept of the model is similar to the BCSM of the CCF. The ITU-T Q.1224 draft recommendation provides a TASM that consists of seven Point In Call(PIC)s and five Detection Point(DP)s[3].

In this paper, we add two PICs and one DP to the model for handover feature as shown in Figure 4. The functions for each of the PICs are as follows.

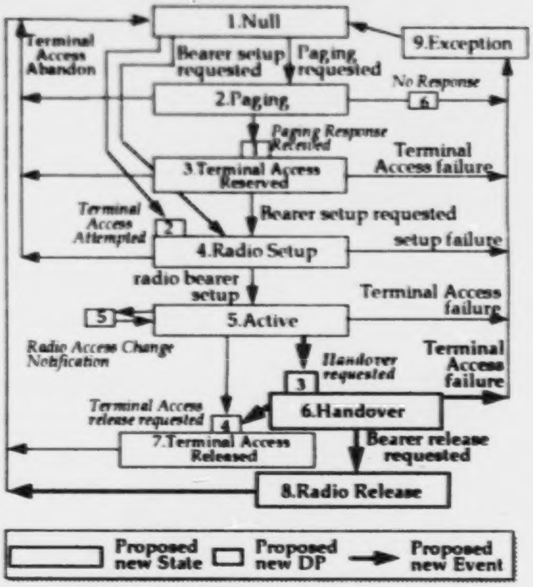

1.Null
9.Exception
Terminal Access Abandon
Bearer setup requested
Paging requested
No Response
6
2.Paging
Paging Response Received
Terminal Access failure
3.Terminal Access Reserved
Terminal Access Attempted
2
Bearer setup requested
4.Radio Setup
setup failure
radio bearer setup
Terminal Access failure
5
5.Active
Radio Access Change Notification
Handover requested
3
Terminal Access failure
Terminal Access release requested
4
6.Handover
7.Terminal Access Released
Bearer release requested
8.Radio Release
Proposed new State
Proposed new DP
Proposed new Event

Figure 4. A Proposed Terminal Access State Model

1) Null

The mobile terminal has not accessed the network, and the state information of the mobile terminal in the network is "idle." If it receives an indication of terminal access from the mobile side, then it occurs Terminal Access Attempted(DP 2) and invokes the Radio Setup(PIC 4). When it detects a request of paging from the SCF, it invokes the Paging(PIC 2). In the case of handover, the request of new bearer setup from the CCF is caused start of the Radio Setup(PIC 4).

2) Paging

For the terminating call to a user on the mobile terminal, paging of the mobile terminal is being executed. When the mobile terminal response to the paging request is received, then it occurs Paging Response Received(DP 1) and invokes the Terminal Access Reserved(PIC 3). When the mobile side does not respond to the paging request before the paging timer expire, it occurs No Response(DP 6) and transits to the Exception(PIC 9). When it receives Terminal Access Abandon event from the SCF, it transits to the Null(PIC 1).

3) Terminal Access Reserved

In this state, the Paging Response Received(DP 1) has been accepted and access of the mobile terminal to the network is being reserved. When Bearer setup requested from the CCF is detected, it invokes the Radio Setup(PIC 4).

4) Radio Setup

Access of the mobile terminal to the network has been accepted and radio channel is being setup. When the radio channel between the mobile terminal and the network is established, it transits to the Active(PIC 5). If the radio channel between the mobile terminal and the network is failed, then it transits to the Exception(PIC 9) causing setup failure event.

5) Active

Access of the mobile terminal to the network has been established and radio channel is being provided to the CCF. Events such as setup of a new call, release of a call, or initiation of handover is being monitored. If the initiation of handover event is received, then it occurs Handover requested(DP 3) and invokes the Handover(PIC 6).

6) Handover

It reports handover initiation to the CCF, and Bearer release requested event from the CCF is being monitored. If release request event from the mobile terminal is detected, then it occurs Terminal Access released requested(DP 4) and transits to the Terminal Access Released(PIC 7)

7) Terminal Access Released

Release of all calls on the mobile terminal has resulted in the release of the mobile terminal access. The access and all the related resources are being released.

8) Radio Release

When Bearer release requested event from the CCF is received, access and the related resources are being released.

9) Exception

Default handling of the exception condition by the CRACF is being provided.

IV. Conclusions

To support handover, this paper proposes redefined the TASM and descriptions of the states on the model. It provides CRACF activities required to process a handover feature and clarifies entry and exit events of each state on the proposed model.

Further study on the call segment manipulation for mobile calls will be done to implement the associated and the multi-party calls. Furthermore, research on how handover procedure impacts on the SSF/CCF should be continued.

References

[1] ITU-T TD 4/11-68, "Section 4.1.1(DFP Architecture) of the Baseline Document for IN CS-2," pp. 22-30, Geneva, May, 1995.

[2] ITU-T Q6/11-BLN-200, "Section 4.1.1(DFP Architecture) of the Baseline Document for IN CS-2," pp. 25-30, Berlin, Nov., 1995.

[3] ITU-T Q6/11-BLN-094, "Proposed modification to Terminal Access State Model(TASM) and TASM description," pp. 3-5, Berlin, Nov., 1995.

[4] Yasuo Maruyama, Katsuhiko Yamagata, and Masami Yabusaki, "Mobile Concept Handling with IN Concept," pp. 2-3, IN'95, Ottawa, May, 1995.

[5] ITU-T TD-Q8/TYO-57, "Version 2.1 of Draft New Recommendation Q.FIF, Information Flows for FPLMTS," pp. 33-41, Tokyo, Sep., 1995.

Open Programmable Switching:
An Enabling Technology for Enhanced Services Deployment

Michael G. Hluchyj
Summa Four, Inc.
Manchester, New Hampshire
USA

ABSTRACT

Competition among telecommunications service providers within the Pacific Rim will accelerate the introduction of new network-based services. Competition among the interexchange carriers in the United States has resulted in a significant increase in the number of new enhanced services offered and a dramatic decrease in the time allowed to bring them to market. The traditional, closed-architected switch, where a single vendor supplies the switch hardware, software and applications, does not provide the required degree of flexibility and openness demanded by this new competitive environment. In the last few years, open programmable switching platforms have emerged as an effective enabling technology in the rapid development and deployment of new enhanced services. Moreover, for new telecom service providers, such platforms can form the switching foundation for both basic and enhanced services.

1. COMPETITION AS A DRIVING FORCE BEHIND ENHANCED SERVICES DEPLOYMENT

In any industry, competition serves as the driving force behind product differentiation, innovation, and time-to-market. Competition within the worldwide telecommunications service provider market is in its early stages. Still, it is clear to all that this market is going through a major transition, primarily as a result of divestiture in the United States and privatization internationally.

Figure 1 illustrates the current state of the telecommunications service provider market and the forces driving its evolution. The matrix plots the current market based on two criteria: the degree of competition and the level of the telecommunications infrastructure. The United States has an advanced telecommunications infrastructure, with the InterExchange Carriers (IXCs), AT&T, MCI and Sprint, engaged in increasing levels of competition (upper-right quadrant). While these carriers certainly compete on price, differentiated enhanced services have emerged as strategic competitive tools (see Section 4 for examples of these services).

Traditionally, the Regional Bell Operating Companies (RBOCs) in the U.S. and Public Network Operators (PNOs) in Western Europe and areas of Pacific Asia enjoyed the benefits of highly advanced infrastructures and a relatively low level of competition (lower-right quadrant). This is changing rapidly, with expected legislation in the U.S. opening up local networks to competition. Outside the U.S., plans for privatization are being made in most of the developed countries.

A significant force behind RBOC and PNO competition is the emerging telecommunications providers: the expansion of cellular through digital technologies and micro-cellular underlay systems, the spectrum auction in the U.S. and subsequent PCS infrastructure deployment, the continued growth of Competitive Access Providers (CAPs), and the application of hybrid fiber-coax systems for the deployment of telephony services (upper-left quadrant). As these emerging players build their telecommunications infrastructure, they will move to the right on the matrix, and force the RBOCs and PNOs to become more competitive.

In most developing countries, there is little competition and a great need to build telecommunications infrastructure (lower-left quadrant). In these countries, what is normally considered an enhanced service, such as voice mail, provides a necessary starting point for infrastructure deployment. Customers have individual voice mail boxes, but use public phones to post and receive messages.

201

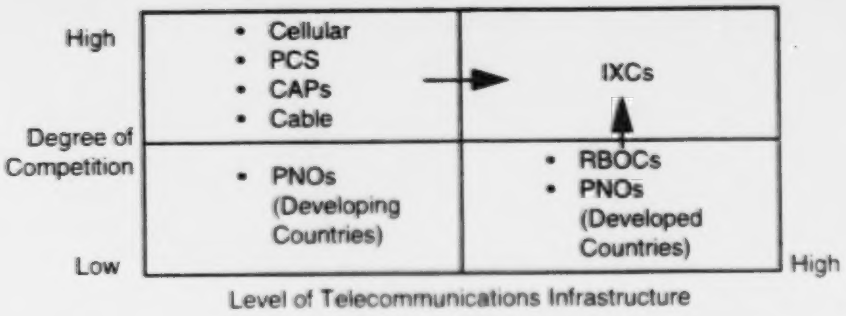

High
Degree of Competition
Low
Cellular
PCS
CAPs
Cable
IXCs
PNOs (Developing Countries)
RBOCs
PNOs (Developed Countries)
High
Level of Telecommunications Infrastructure

FIGURE 1. TELECOMMUNICATIONS SERVICE PROVIDER MARKET

Still, in a free market economy where telecommunications is more deregulated, all roads lead to the upper-right quadrant in Figure 1. As we have already witnessed with the IXCs, differentiated enhanced services innovation and rapid time-to-market are crucial competitive weapons. As we describe later, open programmable switching is emerging as a key enabling technology to drive this competition.

2. OPEN VS. CLOSED SWITCHING

During the last 25 years, communication network technology made great strides toward open network architectures. Standard network interfaces (e.g., ISDN bearer and signaling channels, SS7, X.25, TCP/IP, Frame Relay) were defined, enabling different systems to communicate using layered, peer-to-peer network protocols. This, in turn, allowed one to build communications network infrastructures made of a variety of equipment from different providers. From a basic transport perspective, this is an effective means of building voice and data internetworks.

However, despite having open network interfaces, the system architectures used to build network switches are typically closed. That is, the switch vendor supplies the hardware, software and all applications that reside on the switch. Switching equipment customers depend exclusively on the switch vendor for all upgrades and application enhancements to the switch. This makes it difficult to rapidly deploy new enhanced services as a means of differentiating among competing telecommunication service providers.

This is similar to the early days of word processing, where one vendor supplied the system hardware, software and applications. The introduction of the PC represented a clear trend away from closed-architected computer systems towards open-architected PCs that support multiple applications with different and competing vendors supplying various hardware and software components. We expect the telecommunications industry to follow this same trend toward open systems architecture, as evidenced by the current deployment of open, programmable switching platforms.

3. OPEN PROGRAMMABLE SWITCHING

Open programmable switches, such as the Summa Four VCO® Series 80 switching platform, have been widely deployed by PTTs, IXCs, RBOCs and cellular providers as the core switching vehicle within a Service Node adjunct to the Central Office (CO) switch (see Figure 2). The CO switch provides basic services, while calls requiring enhanced services are routed to the attached Service Node for handling. Here, the open programmable switch within the Service Node allows for the rapid development and deployment of enhanced services provided by a wide range of host software developers.

As with traditional telephony switches, programmable switches offer a wide variety of standard analog (e.g., SLIC, E&M, DID) and digital (e.g., T1, E1, J1) interfaces, along with standard signaling interfaces (e.g., SS7, ISDN D-channel). In addition, programmable switches typically offer a variety of internal service resources such as digital tone generation, DTMF and MF receivers, call progress analysis, conferencing, and prompting/recording functions. But the key differentiator of a programmable switch is the ability to flexibly and efficiently control every element of a call path.

With an open programmable switch, the call model is not pre-defined, with the switch control architecture then built around it. The call model is defined by the application developer. The service logic that results from the specified call model resides in the host controller. To reduce host loading and improve the overall efficiency of the Service Node, service logic macros may be programmed into the switch and then executed under control of the host application. In addition, advanced programmable switches offer resource management functions, where the location and utilization of network interfaces and service resources are managed by the switch. Expensive service resources (e.g., speech recognition) are only applied to a call for the minimum duration required, and then quickly returned to a resource pool for use by other calls. The switch and its resources are controlled by the host application through a specified application programming interface (API) (see Figures 2 and 3).

A telco capable open programmable switch offers one the ability to:

- Program and customize the switch depending on the specific requirements.
- Select best in class service resources and intelligent network host applications.
- Control every element of the call path, without which application development becomes costly and time-consuming.
- Achieve transparent connectivity between the CO switch, host and service resources, which are the building blocks of virtually all intelligent network applications.
- Achieve full compliance with central office standards.

4. EXAMPLES OF ENHANCED SERVICES APPLICATIONS ENABLED BY OPEN PROGRAMMABLE SWITCHING

There are numerous examples of how open programmable switching is used to deploy enhanced services. Below we provide a brief description of a few of these to illustrate the diversity and capability that this approach offers.

800 Call Redirect: An 800-number call initially answered by a service representative in one location is re-directed by a programmable switch to the sales office closest to where the customer has called. In this way, all of the customer's needs are handled with a single 800 call.

Voice Activated Dialing: A programmable switch forms the foundation of an application where a call is dialed simply by speaking into the phone the pre-programmed name of the person you wish to reach. This application is a good example of how rapid time-to-market with key service differentiators are crucial to gaining new business. Both IXC and cellular environments have used this service.

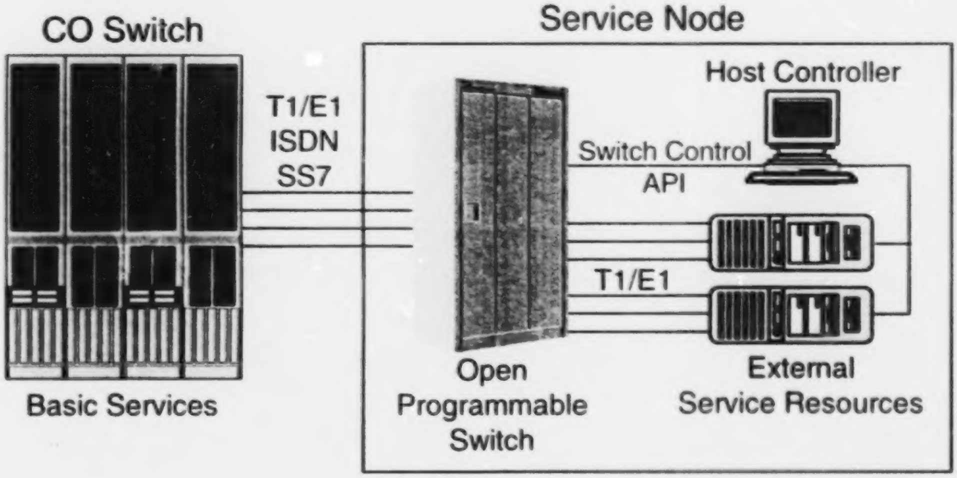


FIGURE 2. OPEN PROGRAMMABLE SWITCHING WITHIN A SERVICE NODE ENVIRONMENT

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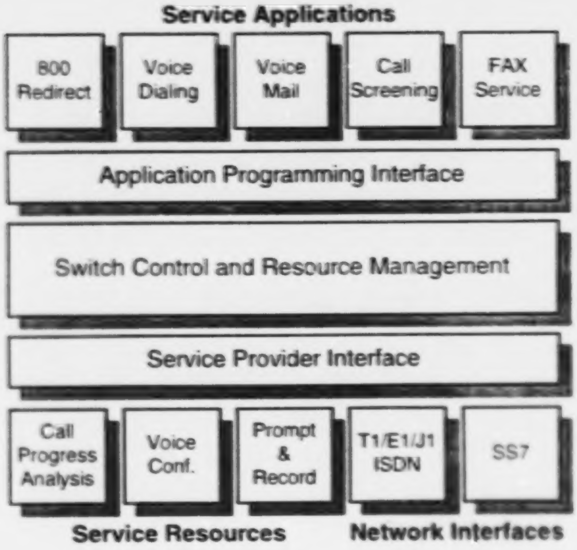
Service Applications
800 Redirect
Voice Dialing
Voice Mail
Call Screening
FAX Service
Application Programming Interface
Switch Control and Resource Management
Service Provider Interface
Call Progress Analysis
Voice Conf.
Prompt & Record
T1/E1/J1 ISDN
SS7
Service Resources
Network Interfaces

FIGURE 3. REFERENCE MODEL FOR OPEN PROGRAMMABLE SWITCHING

Cellular Call Screening: Cellular subscribers screen calls by listening to a verbal announcement of who is calling, and then have the option of receiving or refusing the call. This eliminates the end-user's (subscriber's) cost of receiving unwanted calls.

Voice Mail: Programmable switches are deployed in the delivery of voice mail services to RBOC, cellular and other telco customers.

Information Retrieval: Programmable switches are used to provide traders with up-to-the-minute information on stocks, commodities and bond trading and prices. Users can subscribe to voice, fax or a combination of service responses.

5. OPEN PROGRAMMABLE SWITCHING WITHIN THE AIN FRAMEWORK

With the adoption of the Advanced Intelligent Network (AIN) (and more generically the Intelligent Network) framework (see Figure 4) by traditional telecom service providers, the main functions of a Service Node are divided between the Service Control Point (SCP) and Intelligent Peripheral (IP). Call routing functions are triggered after some or all of the dialed digits are collected and sent to the SCP. The SCP, architected for high-volume, transaction-oriented database functions, can efficiently translate the collected information to the appropriate destination address.

The interactive and processing intensive services, such as dynamic call routing, call screening and voice dialing, present in many enhanced services are developed and deployed using an IP. Here again, as with the Service Node illustrated in Figure 2, an open programmable switch and host application environment allows for the management, control and efficient utilization of expensive service resources. Distributing service logic segments in the IP host controller, together with the flexibility of the programmable switch, allows for the creation of new, caller interactive services beyond those envisioned by current AIN specifications.

6. FUTURE TRENDS: MERGING OF BASIC AND ENHANCED SERVICES SWITCHING

Using an open programmable switch attached to an existing CO switch (in either a Service Node or Intelligent Peripheral application) represents an ideal vehicle to achieve the benefits of programmable switching in existing telecommunications service environments.

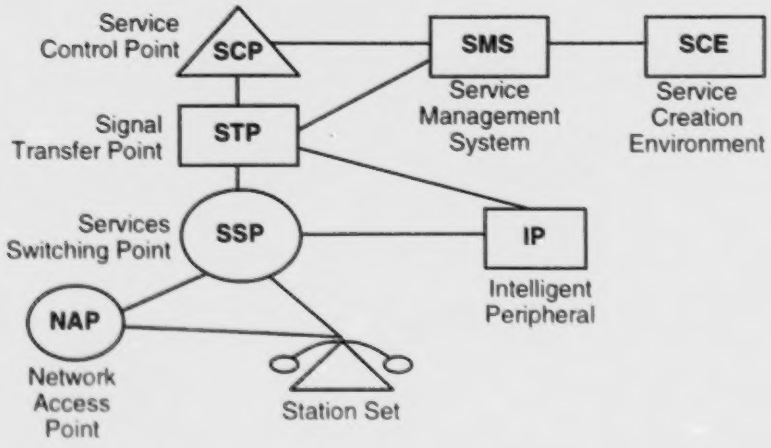

FIGURE 4. REFERENCE MODEL FOR THE ADVANCED INTELLIGENT NETWORK

However, the wireless, cable and competitive access providers (left-upper quadrant in Figure 1) urgently need to build infrastructure and differentiate with enhanced services as they begin to compete with each other and with the established RBOCs and PNOs. Although these new service providers may choose to keep the basic and enhanced services switching functions separate, a more flexible and cost-effective solution is to combine these in a scaleable, open programmable switch. A distributed switch deployment, using an open programmable switching platform, provides an emerging service provider with a competitive telecommunications network infrastructure on which to grow its business. We believe that this segment of the market represents the largest potential for rapid growth and deployment of open programmable switches.

7. CONCLUSIONS

Where there is competition among telecommunications service providers, one finds the greatest need for service differentiation, innovation, and rapid time-to-market. This is also where one finds the greatest need for open, programmable switching platforms. Given the closed system architecture of existing CO switches, programmable switches are typically deployed as adjuncts today. That is, they are used as the core switch within the Service Node for enhanced services provisioning. Even with the deployment of AIN, the IP will take on the processing intensive functions requiring interaction with the calling and/or called parties. Here again, a programmable switch provides the means by which best-in-class service resources can be controlled and managed within the IP. With the extensive deployment of closed-architected CO switches by existing telecommunications service providers, along with increasing competition among service providers, programmable switches will find greater application within these established networks. Moreover, as emerging service providers (e.g., wireless, cable, CAP) build telecommunications infrastructure, programmable switching will likely play an important role in providing both basic and enhanced services.

INTRODUCING TELEDOME SERVICE

Making effective use of the Network Infrastructure in the Age of Multimedia

Naoki Takeda, Ryoji Tsukamoto, Tatsuya Ohtsubo
NIPPON TELEGRAPH AND TELEPHONE CORPORATION
Business Communication Headquarters Network Services Department
1-1-6 Uchisaiwai-cho Chiyoda-ku Tokyo Japan

1. ABSTRACT

In the emerging multimedia era, individuals and companies will find increasingly strong need to access information without delay. Existing telephone networks congest when large numbers of calls are simultaneously placed to the same number. To solve the problem, NTT developed 'Teledome', a mass information service through which Information Providers can simultaneously transmit information to millions of callers from a single recording source. This paper traces the development of Teledome, describes its major features, and discusses some current applications.

2. INTRODUCTION

To meet the increasingly sophisticated service demand of the emerging multimedia era, NTT plans to offer optical access network nationwide by the year 2010. To accomplish this, NTT is working closely with customers to understand their needs. NTT is also conferring with information providers and manufacturers to explore cooperative ventures that could help satisfy those customer needs.

A distinguishing feature of the age of multimedia is that we are increasingly able to get the information we need anytime and anywhere we need it. Individuals and companies more and more see this recently gained capability as an absolute requirement. The net result is a large and growing number of calls involving the communication of a great deal of information. Installing optical cable will enable broadband communications and accommodate this greatly increased flow of information, but this will take time to accomplish. In the meantime, NTT is attempting to reduce congestion by improving the efficiency of the existing network that links homes via metallic cables.

Existing telephone networks are often unable to handle the volume of calls being placed and become congested. This situation can be substantially alleviated with Teledome, NTT's mass information service based on a multiconnection system and an advanced downloading system. Teledome enables customers to provide information to a large number of callers simultaneously. It permits the quick, repeated access to information that is so essential in the new multimedia era.

3. PROBLEMS WITH PAST MASS INFORMATION SYSTEMS

The existing telephone network is likely to become congested when a large number of calls are placed simultaneously. This is especially true with popular mass information services, such as those that provide poll results or sporting information. Information Providers (IPs), callers, and NTT have all suffered due to congestion. The specific problems, experienced from the perspectives of IPs, callers and NTT are described below.

3.1. INFORMATION PROVIDERS

IPs have been hamstrung in a number of ways by the problems that have heretofore afflicted mass information services. These problems include:

- IP's inability to provide information to customers in a timely fashion

  Previous mass information services could provide information only to a limited number of persons at one time. Callers who couldn't get through complained, and IPs are understandably anxious to eliminate the source of these complaints.

- Inadvisability of widely publicizing telephone numbers

  Since callers would complain when they could not get through to access information, IPs would not widely publicize their number in order to reduce the number of complaints. In spite of the known effectiveness of mass media publicity, IPs have to avoid it because of the limited capacity of the telephone facilities.

- The cost of providing information has been proportional to the maximum expected number of simultaneous calls (i.e., no economies of scale)

  With previous mass information services, IPs have incurred costs in direct proportion to the number of calls they need to handle at one time (e.g.,¥26,000 month for a 10 simultaneous call capability and ¥260,000 month for a 100 simultaneous call capability). IPs had to invest in facilities to handle the maximum expected call traffic meaning, in some cases, the installation of hundreds of phones for needs that may arise only for just a few hours on a particular day.

- Excessive incidence of wrong numbers

  Misdialing inevitably occurs with popular mass information services as huge number of people attempt to dial a particular number. This has been very annoying and caused great inconvenience to those residential and business customers with numbers that closely correspond to the call-in numbers.

3.2. CALLERS

The congestion afflicting mass informationsystems has been a problem for callers as well. Principally, callers have been unable to reliably access informationwhen they need it. This problem has varied in importance from an inconvenience to a critical problem. To cite a more critical example, a company could lose a lucrative business opportunity if it is unable to receive information in a timely fashion.

3.3. NTT

Congestion caused by too many calls to a mass information service may cause problems throughout the network, affecting completion rates for general telephone calls. In a worst-case scenario, emergency calls might not get through. The calls that do not get through cannot be charged for, so NTT loses out on a profitable opportunity whenever a call cannot be placed because of network congestion.

4. IMPROVING EFFICIENCY OF THE EXISTING NETWORK

Most of the problems listed above can be substantially corrected by enhancing the efficiency of the network. NTT has focused on two techniques to accomplish this:

4.1. MULTI-POINT CONNECTION SYSTEM

With previous mass information services, each connection between the IP and a caller was "point-to-point" (see Fig.1). With this setup, there needs to be as many connections as there are callers accessing the system at any given time, even though each call conveys identical information. Researchers at NTT saw this as somewhat wasteful and came to believe that, if each connection carries the same content from a voice recording source to the switch, only one connection should be sufficient. With previous mass information services, switches only performed a routing role. With Teledome, switches are part of a multiconnection system. They make multiconnection calls and establish "multipoint-to-point" connections (see Fig.2).

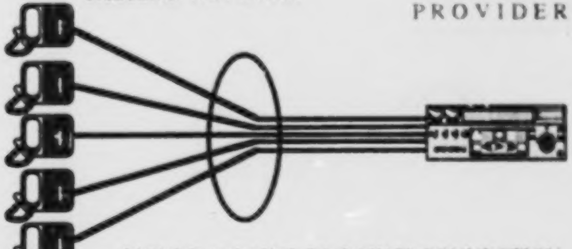

FIGURE.1 "POINT-TO-POINT" CONNECTION

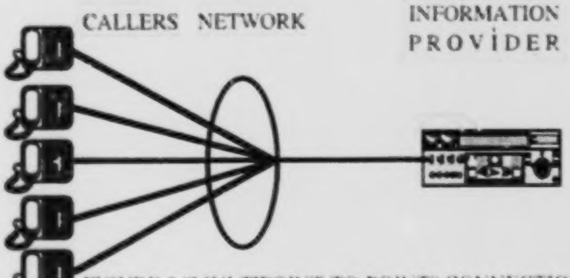

FIGURE.2 "MULTIPOINT-TO-POINT" CONNECTION

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4.2. ADVANCED DOWNLOADING SYSTEM

In order to establish a multipoint connection, switches must be able to recognize which calls are to be multiconnected. With other advanced services, the connection data are provided via a Network Service Support Point (NSSP) and a Network Service control Point (NSP). An NSSP, which corresponds to a Service Management Point in the U.S., contains a customer database and network management functions. It downloads the customer data necessary for service processing to an NSP. The NSP, which corresponds to a Service Control Point in the U.S. performs service analysis and control in real time.

The switch where a call occurs must access the NSP to pull out the information for each call. However, in Teledome the signaling network and NSP might be overloaded by mass, simultaneous traffic. To handle this situation, NTT created switches with virtual NSPs, and the real NSP downloads connection data to the virtual NSPs before service begins.

5. TECHNICAL ASPECTS OF MULTI-POINT CONNECTION SYSTEM

Teledome is designed for the one-way provision of information so it does not have to carry caller voice or data information to the IPs. With the first call, a connection is established between the caller and the terminating IP in the usual way. When a second call occurs while the first is still in progress, it is multiconnected at Ground Center (GC) 1, a local switch, because the connection beyond that point has already been established. A third simultaneous call is terminated at the Zone Center (ZC), a toll switch. In this way, calls to the same IP are terminated at the nearest point (see Fig.3).

More to say, suppose the first call occurs at GC1. GC1 converts the service number to the connection number with the previously downloaded call connection data. The system recognizes that the call needs to be multiconnected and stores that information. The switches, including GC3, receive the connection number and learn that the call needs to be multiconnected from GC1. After that, every call to the same IP is multiconnected. Checking the previously stored information, the second call is multiconnected at GC1. The third call is still the first call for GC2, so GC2 goes through the same process as GC1 did earlier. Since the connection has already been established after ZC, and is checked with the information from GC1, the third call only needs to be multiconnected to the connection of the first call.

This method offers two major advantages. First, In theory no congestion occurs at the call terminating end even when there are a large number of simultaneous callers. Second, the cost of installing new circuits to carry related traffic is minimized. With previous mass information services, the same number of connections were needed as there were callers. With Teledome, there is always just one connection at the terminating end, regardless of the number of callers. This is an efficient utilization of the network.

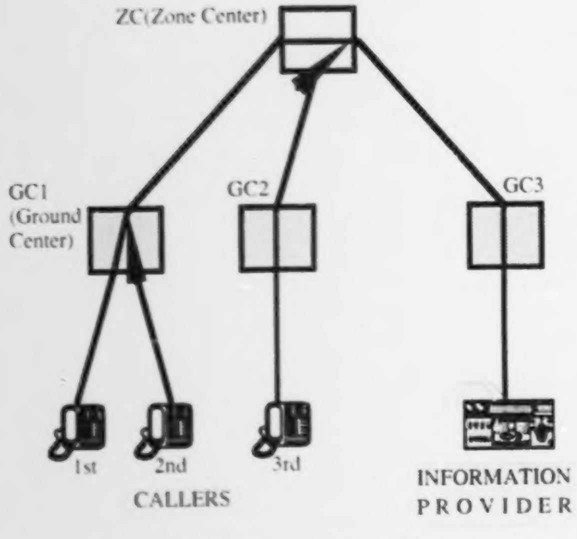

FIGURE.3 MULTI-POINT CONNECTION SYSTEM

6. TECHNICAL ASPECTS OF ADVANCED DOWNLOADING SYSTEM

The functions required for advanced services such as Free Dial (800 services in the U.S.) or Dial Q ^{2}(900 services in the U.S.) are usually located in intelligent nodes like a Network Services Support Point (NSSP) or a Network Service Control Point (NSP). This sort of function allocation encounters problems in dealing with mass traffic. When mass traffic is nearly simultaneous, the signaling network and intelligent nodes may become overloaded. This, in turn, can affect other signaling messages - even those for general telephone calls. Because of the problems, a new method had to be devised for handling mass traffic.

In the new intelligent network architecture developed by NTT for handling mass traffic, the required functions and customer data are downloaded from intelligent nodes to the Group Centers (GCs). This data downloading enables GCs to handle subsequent calls in the same manner as an NSP. In a sense, this has the effect of creating a virtual NSP in the GCs. The method thus relieves the NSPs of congestion caused by mass traffic, enabling a large volume of calls to be handled simultaneously at the GCs (see Fig. 4).

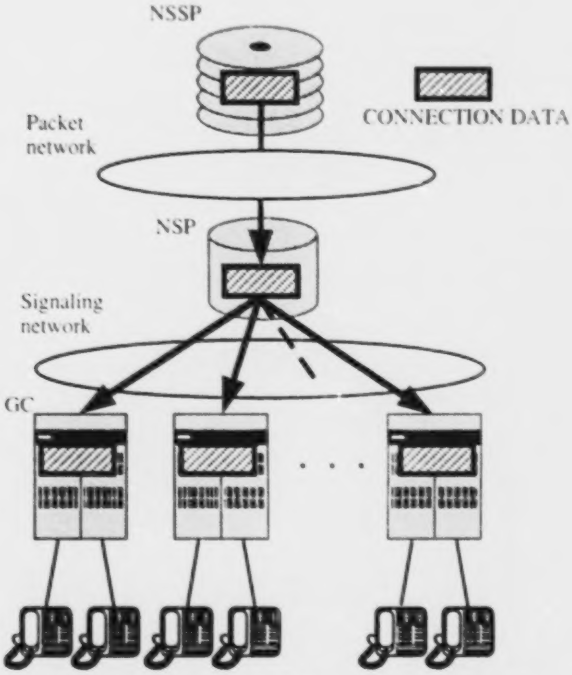
NSSP
CONNECTION DATA
Packet network
NSP
Signaling network
GC

FIGURE.4 ADVANCED DOWNLOADING SYSTEM

7. MAJOR SERVICE FEATURES

Figure.5 (below) illustrates the major service features of Teledome.
Major functions and features include the following:

- Exclusive service number

  The number for Teledome service was set exclusive at "0180-99XXXX".

- Customer control functions

  IPs can control certain aspects of service from the customer's PC : control while the program is being broadcast (start/stop of the service) ; and, a daily detailed summary of traffic data (calls by day and by prefecture).

- Call disconnect function

  In the event callers leave the phone off the hook by accident, the network breaks the connection automatically after 60 minutes.

- Charges

  The charge to IPs for the use of additional functions is ¥50,200/month, or ¥5,020/day for non-permanent use. The charge to callers is the same as for ordinary user-dialed calls.

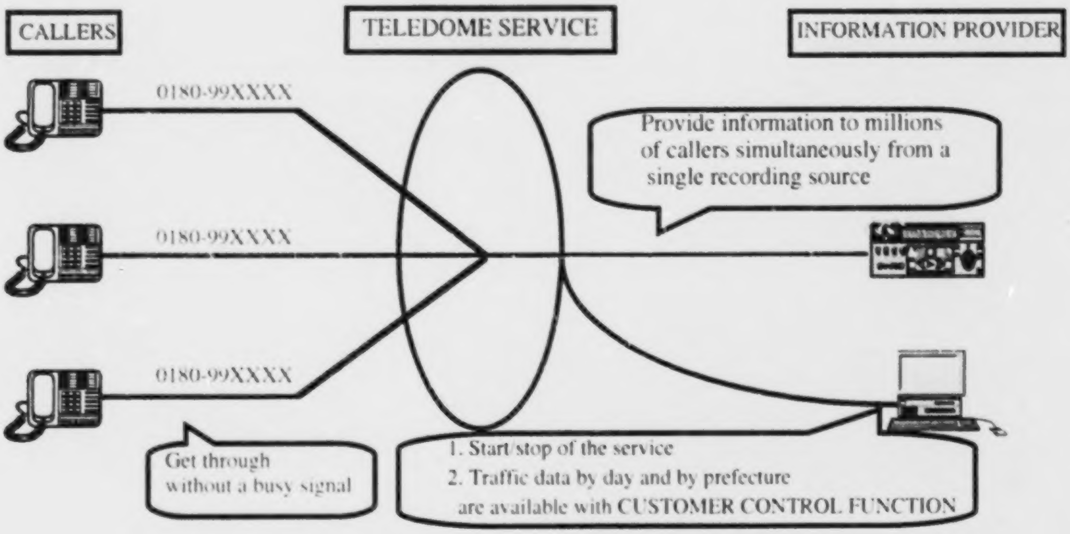
CALLERS
TELEDOME SERVICE
INFORMATION PROVIDER
0180-99XXXX
0180-99XXXX
0180-99XXXX
Provide information to millions of callers simultaneously from a single recording source
Get through without a busy signal
1. Start/stop of the service
2. Traffic data by day and by prefecture are available with CUSTOMER CONTROL FUNCTION

FIGURE.5 MAJOR SERVICE FEATURES

8. BENEFITS OF TELEDOME

Teledome solves various problems experienced with mass information services in the past. The following is a list of benefits that Teledome provides for IPs, callers and NTT.

8.1. TO INFORMATION PROVIDERS

A large number of new benefits accrue to information providers with the use of Teledome.

- Enables IPs to provide timely information to a many simultaneous callers with a single telephone line

  Theoretically, Teledome enables a contracting IP to provide information to up to about 2,000,000 simultaneous callers from a single voice recording source. In actual practice, Teledome has enabled the processing of about 40,000 calls in one-half hour without any callers experiencing a busy signal.

- Enables the full exploitation of mass media advertising

  Since, with Teledome, almost all calls get through without a busy signal, IPs can extensively advertise their service number on TV, radio or in magazines or newspapers without fear of congestion, busy signals and the consequent customer frustration.

- Reduces costs for Information Providers

  Previously, mass information services were costly to provide because the cost of provision was directly proportional to the number of people receiving the information. With Teledome, IPs can provide information to many people from a single recording source and the cost never exceeds ¥ 50,200/month, regardless of how many people access the information. For example, it previously cost ¥260,000/month to provide information to 100 person at one time through mass information services. With Teledome it costs less than one-fifth that amount to provide information to many thousands of simultaneous callers.

- Fewer wrong numbers

  Use of the exclusive service number "0180-99XXXX" reduces the incidence of wrong numbers, removing another disincentive to the widespread advertising of the IP service number(s).

- Convenience of customer control functions

  With the customer control function, IPs can control the start and stop point of service, as well as check the traffic data for program calls by date and prefecture. Control of the start and stop service points is useful when IPs change the information resource. IPs can use of the traffic data as resource of marketing plans.

8.2. TO CALLERS

One big advantage accrues to callers.

- Receiving information in a timely manner

  Whenever the company or personal goals in seeking information from IPs, receiving that information in a timely fashion serves those goals.

8.3. TO NTT

A number of advantage also accrue for NTT.

- Reduces network traffic congestion

  This promotes the smooth operation of the entire network

- Effective utilization of the network

  Teledome more efficiently establishes connections between callers and IPs, thereby enhancing overall network efficiency.

- Ensure that each call gets through so potential revenue is not lost

  Teledome helps create greater profits by transforming non-income generating busy signals into income generating successful connections.

9. RESPONSE TO TELEDOME SERVICE

NTT began offering Teledome service in November 1993 in major Japanese cities. In April 1995 the service was extended nationwide in response to IP and caller demand. About 200 IP programs have been offered from the beginning of Teledome service through the June 1995. The following provides a glimpse of some of the programs and caller response so far.

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- Sporting event information and results

  Some programs give information about where and when events are scheduled or, alternatively, give the results of games or races. The numbers to call are advertised in newspapers or magazines. Such services have been offered in the past but callers have often been frustrated by busy signals. Almost all calls go through with Teledome. Calls for result-oriented programs tend to be concentrated immediately after games so IPs had to invest heavily in facilities if they were to handle peak traffic. One of the most popular programs receives 30,000 calls per day.

- Publicizing ways to subscribe to prizes on TV programs

  Teledome is very effective for TV promotions in which, at the end of the show, a number is given which viewers can call to receive details about viewer quizzes which, when answered correctly, will mean prizes for viewers who send in postcards and have their cards selected in a drawing. In case where the information was given out via Teledome, as many as 40,000 calls will be placed for 30 minutes. This type of promotion could never have been carried off using the previous technology.

- Rapid reporting of poll results

  Several programs have offered polling results for political contests. The service begins when the polls are closed and ends when the actual counting is completed. As many as 10,000 callers have used one of such programs.

- Introducing the voices of animated characters

  Service numbers for accessing the voices of animated characters are publicized by magazines for primary school students. About ten such programs have been offered and they are very popular among students. As many as 5,000 calls have been placed for one of the programs.

- Revealing the day-by-day activities of famous personalities

  Also popular among the young, there are three such programs and about 10,000 calls per day made for one of the programs.

10. CONCLUSION

Teledome offers benefits to all parties involved : callers, IPs, and NTT. Callers can get through at any time. IPs can extensively publicize their numbers, increasing their subscribership dramatically. NTT can reduce traffic congestion and improve the efficiency of their network infrastructure.

All the programs offered through Teledome until now are strictly providing voice information. Some IPs are planning to provide data information via Teledome directly to personal computers. The simultaneous provision of data to large numbers of people is already being made possible by some PC software. Used in conjunction with such programs, Teledome promises to provide a solid foundation for the coming Multimedia Age.

211

The Future Infrastructure for Commerce and Social Interaction - Ending the Tyranny of Distance, Place and Organisation

Robert G James
Group General Manager
Strategic Development Unit
Telstra Corporation
Melbourne, Australia

1. *Introduction*

I believe that today we are seeing the beginning of profound changes to the infrastructure of commerce and social interaction.

The switched communications of telephone companies, the information handling ability of the computing industry and the broadband networks delivering Pay TV to the home, are coming together - converging - to create high speed, switched, information networks which will link our homes and businesses.

This is happening much faster than we anticipated, and, I suggest may happen at a much lower cost than we would have imagined possible only a year or two ago. The consequent impact will be huge not just on telephone companies, but also on our industries and on the way most of us live and work.

2. *Technology Changes - The End of the Golden Age of Telephony*

I believe that we will look back on this period as the golden age of telephony.

A time, following the building of national infrastructures by state monopolies, when costs were falling faster than prices and phone companies had become some of the largestand most profitable enterprises.

The scale and profitability were then the lures for the competition which erupted around the world.

A time when the new competitors for long distance could set up newer, simpler and cheaper infrastructure than the former monopolies who carried a legacy of organisations and facilities based on earlier generations of technology.

A time before the local access monopolies were challenged by cable television companies offering cheaper voice, data and video services direct to the customers home or business.

And lastly, a time when the technology of the computer industry was yet to cross the gulf and become indistinguishable from that of the communications industry.

These changes in technology are being matched by new concepts which transcend today's models for telephony, TV and computing. I should be able to watch a football match from home. Call a friend and, while seeing each other in "picture in picture" windows, discuss the game that we watch on our screens. Then, we might order tickets for the next game. Today this needs three appliances (TV, telephone, PC), three subscriptions, three instruction manuals and three national infrastructures. In future, only one.

The same architectures (such as TINA) that support convergence are also likely to turn networks into open platforms. Introducing new and rich services may be no harder than connecting a server to the Internet today and this will enable a level of innovation on a global scale that has only been seen before in PC software in the late 80s and 90s and, following the invention of the printing press in the 15th(?) century.

I believe that we live in a time of profound technological change, when the barriers that exist in national legislation and, even more importantly, in our minds are falling, and a new order is emerging. A world of information applicances, transparent and much lower cost networks, and where servers at the edge of the network will offer information, entertainment, business transactions and even voice services.

3. *Changing Economics of Communications*

We have seen dramatic changes in the computing industry where twice as much is delivered every year for about the same price, but we have not seen similar economies in communications. Why is this the case when the same digital technology underpins both industries?

The reasons include:

- the basic product (calls) is mature
- cannot double usage each year
  - would need to be on phone 24 hours per day within 6 years
- industry structure - fewer suppliers (10) to fewer customers (20 large telcos)
- legacy structures of telcos - number of sites, products, staff

The economics of communications will however undergo radical change over the next decade. Telephony, TV and interactive services will share a single infrastructure, the cost of which is similar to the traditional copper telephone network but with a 100 fold capacity increase. A movie lasting 30 times longer than a telephone call and needing 100 times faster information transfer will cost only a few dollars - and, if the same pricing applied to a telephone call, it would cost only thousandths of a cent. So we do see the economics of the computing industry applying to communications, but for this to happen, we will need to replace much of the customer access network and vastly expand our core networks - at a cost of around A$10B for Australia.

The new networks will be architected around the cost of glass and labour and we can imagine countries as large as Great Britain served from no more than 20 sites. Networks used to be architected around the cost of copper and as a consequence we have 5000 switching sites in Australia today. This is likely to change by a factor of up to 100.

With these new architectures, we can expect to deliver vastly more at little more than today's prices. And, we can hypothesis new uses for 100 or 1000 times more capacity.

4. *New Architectures for Service Delivery - TINA (Optional for Highly Technical Audiences)*

Before I finish, let me talk about the evolution of a single architecture for communication, computing and even TV.

A TV tunes in a "channel", a computer terminal has a "session" while a telephone makes a "call" - three industries, three terminal appliances, three definitions of how a "service" is delivered. Convergence will be complete when these industries share the same appliances, networks and "service" definitions:

- one hardware and software model for the information appliances - as there is today for the PC
- a common set of standards such as MPEG and ATM, which are not industry specific-unlike SSNo. 7, Netbios or PAL - D
- a "service" model that allows multiple communications carriers to deliver services to customers in different countries using the equipment of different vendors - as there is today in the telephone world.

The first two of these-universal terminals and transparent networks-are likely to be provided from the convergence of communications and

213

computing around entertainment. The next generation of set - top boxes for interactive TV will be digital, incorporate microprocessors, an operating system and a communications card. The early units will inevitably be as different as the first microprocessor based personal computers.

The same forces which brought about standardisation on the IBM PC architecture are likely to cause a shake-out in the market and a small number of dominant models.

For similar reasons to communications protocols having become standardised in the computing industry (X.25, TCP/IP), new protocols are likely to become standard in the newly converging arena - ATM is well on this path already.

The third area of service models has not been as successfully addressed by the computer industry - perhaps because the various proprietary models have been rich in capability and attempts at standards have been an impediment to fast innovation.

Conversely, the communications industry has a long history of acting globally to develop the models for communications which allow multiple carriers and multiple equipment vendors to all participate in the largest and fastest interconnected machine ever built. Dial the number of any phone in the world and in a few seconds it will ring - a truly amazing achievement. This is unfortunately balanced in recent years by an absence of significant new services. Yes, we have cellular mobile and ISDN, but the average telephone service in the average house is almost unchanged in fifty years.

I ascribe this to a number of factors. First, the telephone at over 100 years old is very mature. Second, it performs its basic function very well today, as it has for the last 100 years. Third, while we now build telephone networks using the most advanced of technologies, the architectures have evolved only a little from the networks that predated the valve, transistor and microcircuit - perhaps because backward compatibility has always been vital.

Seen from this perspective we now have 3 mature, but insular industries, ready for a major paradigm shift. Work is already underway on the development of a single multimedia service model called TINA - the Telecommunications Information Networking Architecture which makes no distinction about the content of a service and uses one distributed computing model to embrace intelligent networks, network management (TMN), client server computing and the delivery of entertainment.

5. Micro Economic Reform on a Macro Scale

Fundamentally new communications capabilities such as the printing press and the telephone changed society and even forms of government. The renaissance needed the printing press for literature and the free exchange of ideas to flourish.

National government and national business management became much easier with the advent of instantaneous national communications towards the end of the last century. We should now expect the new infrastructure to dramatically change how we live, work and play.

These new networks offer the prospect of more immediate, personal and more richly featured access to our family and friends but also, to our customers, suppliers, financiers and government. Today, I wish to focus mainly on the business implications.

For many industries, the cost of distribution can today be 60% or more of the sale price or, 60% of the company's added costs. Entertainment and "software" of all kinds are readily seen examples. As well, all kinds of branch services such as banking are further examples. Even the distribution of toys, potato chips and petrol can be made faster and cheaper using networks.

As a very small current example, when I fill my car with petrol in the USA, I swipe my credit card through the bowser and then fill my car. As great a flow of value occurs through the network, as through the bowser. Even this simple purchase of a physical commodity has involved a communications company and a bank, yet has been faster, cheaper and more convenient for both the customer and the supplier.

The business school case studies of Toys R Us, FritoLay and Walmart are well know examples of using current technologies to improve distribution of more complex products. These case studies typically involve shortened distribution chains, manufacturing-on-demand based on point-of-sale feedback each time a sale is made, and innovative financing eg goods are paid for by retailer only when sold.

With more advanced networks we can extend these stories to every business and all the way from the original supplier to the final consumer, eliminating any step which does not add value to the consumer - including in some cases, the physical "point of sale" itself. For example, I might order a rental car using a personal digital assistant (PDA) while travelling to the airport or order a custom built mountain bike via the set-top box on my TV, or pay a road toll simply by driving up the ramp.

What will change? First, the pervasiveness of network access - anyone, anywhere. My customers and suppliers, in Australia and overseas will all be immediately accessible. Second, the ready availability of network based services for commerce to every business. This will enable and drive the re-engineering of distribution. These capabilities, which could once only be established after considerable effort and cost in large national or multi-national firms (eg EDI), will be able to be readily applied by small business and be spontaneously used with 100s of trading partners and millions of potential customers. New businesses will be able to be established much faster and, the velocity of the circulation of money may well multiply.

The communications and computing industries must themselves be re-engineered for this to happen. We can envisage more Internet like models emerging where a "transparent" and very low cost carriage infrastructure links any user to any other user and to any supplier. In these networks, carriage is low in value added and services of every type are delivered from the edges of the network - even directories and switching of all but the most basic type. While this threatens traditional telco approaches to adding value, it opens the possibility of fundamentally new services and creates a new dimension for competition in service offerings.

One of today's industries to benefit is computing itself. The sale of services can replace the sale of computer hardware and software. An airline might buy airline reservation services on a transaction basis rather than buying computer hardware, computer software and data lines.

The vendor receives a regular income stream which is no longer tied to a single large sale, while the buyer makes fixed costs variable and is able to focus on core business activities. Communications and computing will have become a part of nearly every product.

Overall, I can expect that within 10 to 15 years, new industry structures will have evolved around how I work, fill my car with petrol, buy at the local store, watch movies, pay bills, make calls or interact with government.

6. *Global Business Models*

Distance is a barrier to business today. It is easier to buy a book locally, to bank locally and only the local phone company can provide local value added services. But the time will come when this changes, and we can see evidence of the new models today.

215

year. None-the-less, the imminent changes should cause us to rethink or at least review our plans for national infrastructure.

For countries such as Australia, which do not have Pay TV, we can see ourselves stepping past simple broadcast networks to two way, interactive broadband networks. For countries without national telephone infrastructure, it may well be ***cheaper*** to install broadband networks with far fewer network nodes than traditional telephone networks - even if telephony is the only service to be offered initially! And, it will certainly provide a better platform for business in key cities.

9. *Conclusion*

With such a framework we can imagine a world where:

- any product is available on any appliance
- mix and match - watch a football match on TV, talk to friend in a picture in picture window and buy tickets for the next game
- transparent universal networks allow the connection of any appliance to any server
- networks are as much open platforms as PCs - offering new services would be as easy as connecting a server to the Internet today
- regulations will have to be framed around effects and outcomes, not the means of delivery
- boundaries are no longer corporate (as in computing), regional (as in TV) or national (as in telephone companies).

In all, a borderless world.

I mentioned at the beginning, that I thought that this is the "golden age" of telephony.

In hindsight, we can always see the golden age of a civilisation or business when it's power and wealth peaked before some decline.

Today, we don't need to wait for hindsight, the signs are clear for ***traditional*** "Telephony" that it's golden age has arrived and will soon depart. However, the opportunities for telephone companies and anyone else in Information Networking are truly boundless.

Efficient Broadcast File Transfer in a Satellite Communications Network

Gernot M. Engel, PhD
Titan Information Systems Corporation
Dwight R. Bean, PhD
University of San Diego
San Diego, California, U.S.A.

1. ABSTRACT

A file transfer protocol used for broadcasting a file to a set of nonhomogeneous sites is described. Files are partitioned into packets. Only those packets received in error are retransmitted. The optimal packet size which maximizes throughput, based on the bit error rates at each of the sites, is derived.

2. INTRODUCTION

Satellite networks in which resources are demand assigned require distributed processing of network protocols. Often these networks are distributed over a wide geographical region with member sites at remote locations that are unmanned, or at best, staffed by untrained personnel. If protocols are not built into the network management system for seamless automatic distribution of software, then once the network is fielded it will be unlikely that the system will evolve. It will be almost impossible to modify protocols or upgrade the software and the system will become obsolete. In this paper we describe an efficient broadcast protocol used to distribute control software in a full mesh network.

3. BACKGROUND

The Titan DAMALink system utilizes both Frequency Division Multiple Access/Time Division Multiple Access (FDMA/TDMA) and Single Channel per Carrier (SCPC) modems to support a broad range of applications. The FDMA/TDMA modems at each site are used to provide efficient use of bandwidth for transaction-based systems and narrowband packet services, as well as network control. The SCPC modems are used to support high data rate services such as video and voice conferencing and T1 or greater high rate data services. Figure 1 depicts an example burst schedule in time and frequency.

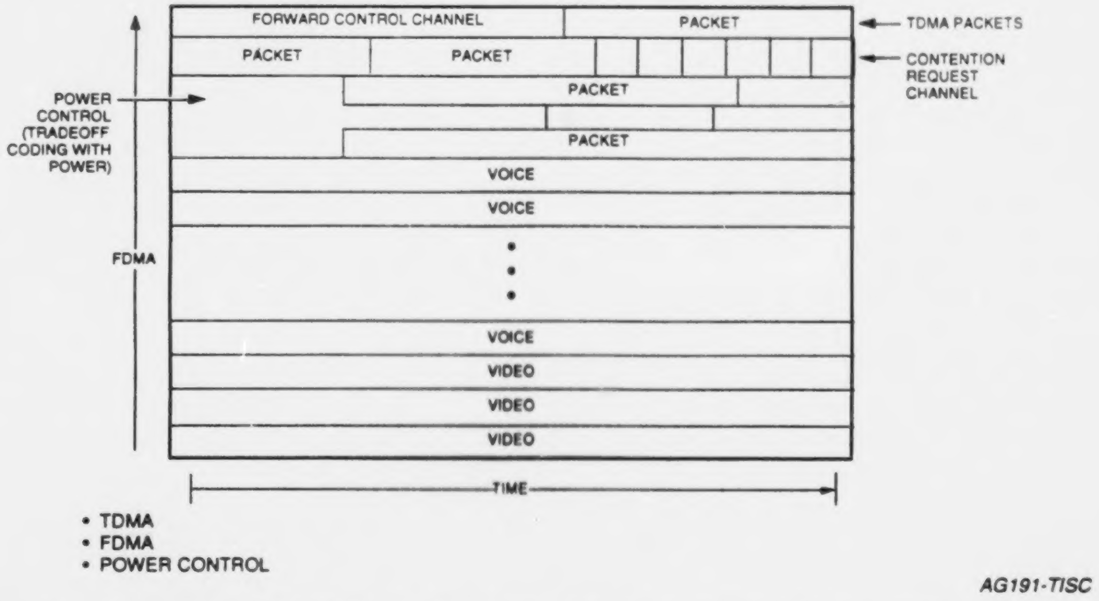
FORWARD CONTROL CHANNEL
PACKET
TDMA PACKETS
PACKET
PACKET
CONTENTION REQUEST CHANNEL
POWER CONTROL (TRADEOFF CODING WITH POWER)
PACKET
PACKET
VOICE
VOICE
FDMA
VOICE
VIDEO
VIDEO
VIDEO
TIME
• TDMA
• FDMA
• POWER CONTROL
AG191-TISC

FIGURE 1. MINIMIZING TRANSMISSION TIME IN AN FDMA/TDMA SYSTEM WITH VARIABLE POWER

To ensure positive control of the network during all phases of execution, each site, as well as the network control station, is equipped with at least one FDMA/TDMA modem. This modem is interfaced to the control processor using a serial link (see Figure 2). The control processor is used to monitor and control SCPC modems, transceivers, multiplexers and FDMA/TDMA modems. Software download is performed using a broadcast file transfer protocol.

4. BROADCAST FILE TRANSFER PROTOCOL DESCRIPTION

The broadcast file transfer protocol used is an extension of a common point-to-point file transfer protocol (see Ref. 1). Data is transmitted in short bursts called packets. Each packet has a checksum covering the packet data. Packets received in error are retransmitted. The amount of data in each packet is determined by the central controller based on the channel bit error rate.

The point-to-point file transfer protocol is executed as follows:

1) Using an Aloha protocol, the net member informs the controller the size of the file to be transferred.

2) The controller acknowledges the request and assigns a unique file identifier to the service. It then starts to allocate capacity to the sending modem using the control channel to inform the sending modem and the receiving modem where in the spectrum the packet is to be burst, the packet size, and the starting and ending byte position of the data interval for the identification of the file that is to be transmitted.

3) The transmitting modem transmits the data as dictated by the controller. After each burst of data is received by the receiving modem, the receiving modem calculates the checksum and compares it with the transmitted checksum. Data for which the checksum is equal to the transmitted checksum is buffered.

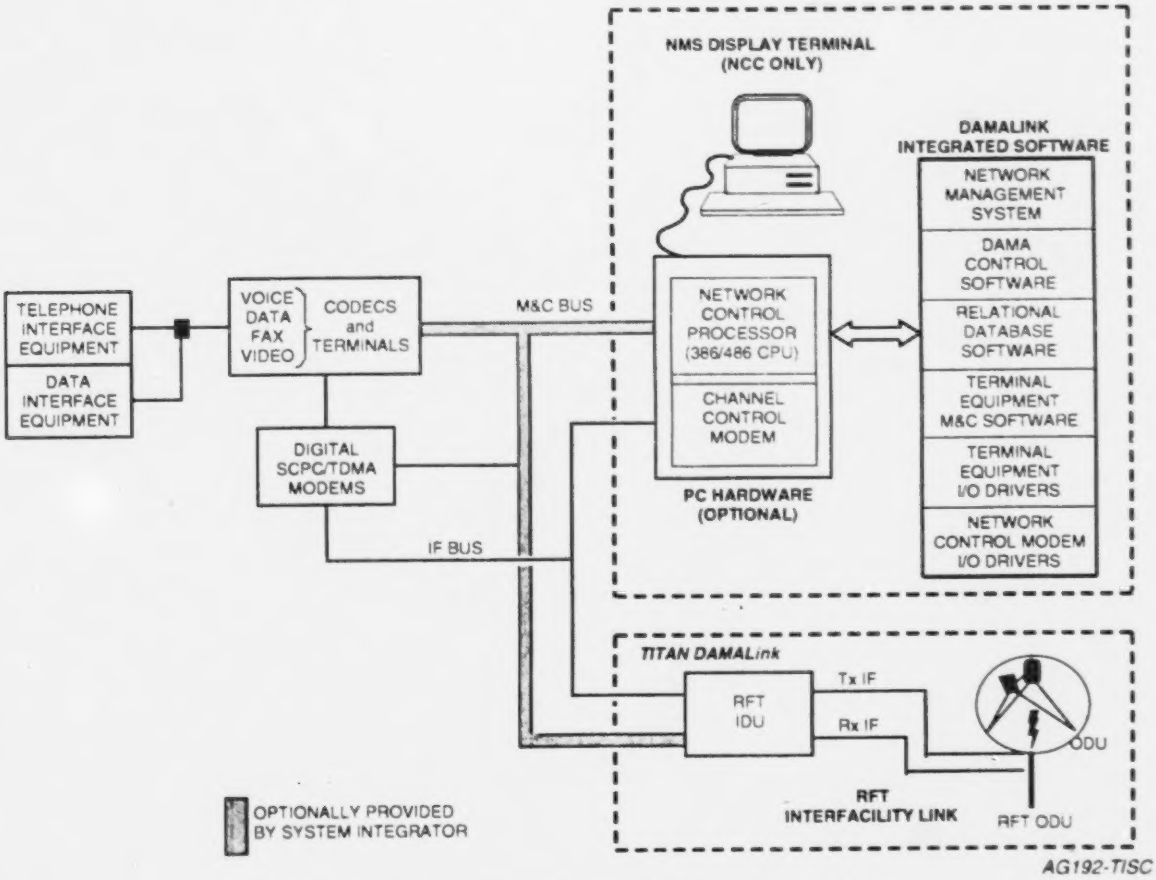
NMS DISPLAY TERMINAL
(NCC ONLY)
DAMALINK
INTEGRATED SOFTWARE
NETWORK
MANAGEMENT
SYSTEM
DAMA
CONTROL
SOFTWARE
RELATIONAL
DATABASE
SOFTWARE
TERMINAL
EQUIPMENT
M&C SOFTWARE
TERMINAL
EQUIPMENT
I/O DRIVERS
NETWORK
CONTROL MODEM
I/O DRIVERS
TELEPHONE
INTERFACE
EQUIPMENT
DATA
INTERFACE
EQUIPMENT
VOICE
DATA
FAX
VIDEO
CODECS
and
TERMINALS
M&C BUS
NETWORK
CONTROL
PROCESSOR
(386/486 CPU)
CHANNEL
CONTROL
MODEM
PC HARDWARE
(OPTIONAL)
DIGITAL
SCPC/TDMA
MODEMS
IF BUS
TITAN DAMALink
RFT
IDU
Tx IF
Rx IF
ODU
RFT
INTERFACILITY LINK
RFT ODU
OPTIONALLY PROVIDED
BY SYSTEM INTEGRATOR
AG192-TISC

FIGURE 2. TITAN DAMALINK SYSTEM BLOCK DIAGRAM

Data for which the checksum fails is placed in a separate buffer together with the starting and ending byte position data and is available for error correction when retransmissions occur (see Ref. 2).

4) The receiving modem maintains a database containing the starting and ending byte positions of the disjoint intervals of file data that have passed the checksum criteria. The end point of the interval containing byte position 0 is called the high water mark. If there is more than one interval in the database, the receiving modem transmits the high water mark together with the starting position of the next interval received without checksum error together with the unique file identifier. An Aloha slot is used for this transmission.

5) Each time the controller receives a high water mark transmission, it allocates capacity to fill in the missing data. When there are no missing data, the controller continues to allocate capacity until sufficient capacity has been allocated to complete the entire transmission of the file.

6) Once the entire file has been transmitted, the controller polls the receiving modem for a high water mark. If high water mark matches the size of the file, the protocol is terminated by the controller and the member marks his file as received.

This protocol is extended to a broadcast protocol by requiring that the network controller make a list of all the sites the file is to be broadcast to. The modem at the top of this list will be referred to as the designated user. The broadcast file transfer protocol is executed between the transmitter and the designated user the same way the point-to-point protocol is executed. The only difference is that all the modems in the broadcast group perform all the operations that the designated user does except inform the controller of their high water mark. Once the designated user has received the file, he is removed from the list of sites the file is to be broadcast to and the next site on the list becomes the designated user and is polled by the controller for his high water mark. At any point in the protocol, if a site on the list has received the file, the site uses the Aloha channel to inform the controller that he should be removed from the list. Once the list is empty the protocol is terminated.

---

5. DERIVATION OF OPTIMAL PACKET SIZE

Given BER = channel bit error rate and n = number of members in a broadcast group, we want to find the packet size S in bytes that will maximize file transfer efficiency. File transfer efficiency (FTE) is defined to be user data bytes divided by total bytes transmitted, so

$$\mathrm{FTE} = \frac{NS}{N'(S + \mathrm{Ovrhd} + \mathrm{Pream} + \mathrm{FOW}) + (N' - N + n)\mathrm{ROW} + \mathrm{OneTime}} \qquad (1)$$

where

N = number of packets

N′ = actual number of packets transmitted

Ovrhd = CRC bits + protocol overhead (about 8 bytes)

Pream = packet preamble size (about 63 bytes)

FOW = Forward Orderwire
= control channel scheduling bytes per packet (about 14 bytes)

ROW = Return Orderwire
= acknowledge and reporting bytes per packet (about 12 bytes)

OneTime = One time setup and teardown bytes (negligible)

Let E = expected number of times a packet must be broadcast. Then $N' = NE$ and

$$\mathrm{FTE} \approx \frac{S}{E(S + 97) - 12}$$

E depends on n and the probability p of missing a packet,

$$p = p_p + p_b - p_p p_b$$

where

p_p = probability of missing a packet preamble (preamble selected so $p_p \approx 10^{-4}$)

and

p_b = probability of missing the packet data
$= 1 - (1 - \mathrm{BER})^{8(S + \mathrm{Ovrhd})}$ (2)
(8 bits per byte)

Actually, the n broadcast members may have different BERs, so let p_i be the probability that the ith member misses a packet.

Then the probability that exactly k transmissions are required for member i = $p_i^{k-1}(1-p_i)$, so by telescoping sums, the probability that no more than k transmissions are required for member i is $1-p_i^k$. Assuming independence, the probability that the n members require no more than k transmissions to receive a packet is

$$\prod_{i=1}^{n}\left(1-p_i^k\right) = 1+\sum_{r=1}^{n}(-1)^r \sum_{1\le i_1<i_2<\dots<i_r\le n} p_{i_1}p_{i_2}\cdots p_{i_r}$$

Then we have

$$E = \sum_{k=1}^{\infty} k\left[\prod_{i=1}^{n}\left(1-p_i^k\right) - \prod_{i=1}^{n}\left(1-p_i^{k-1}\right)\right].$$

By expanding products as above, switching sums and summing geometric series, we derive

$$E = \sum_{r=1}^{n} (-1)^{r+1} \sum_{1\le i_1<i_2<\dots<i_r\le n} \frac{1}{1-p_{i_1}p_{i_2}\cdots p_{i_r}}. \quad (3)$$

Combining equations (1), (2) and (3), we can calculate FTE for any fixed values of BER, S and n. Thus we can find S optimizing FTE. In practice we make simplifying assumptions. Since FTE(S) curves are of the form shown in Figure 3, we need to ensure that the approximation for S is ≥ $\hat{S}$. If we assume all members are advantaged, we get a simpler expression

$$E = \sum_{r=1}^{n} (-1)^{r+1}\binom{n}{r}\frac{1}{1-p^r}$$

which will guarantee a selection S ≥ $\hat{S}$. Using the approximation, packet size S optimizing FTE was determined numerically for various values of BER and n. It turns out that S and E are relatively stable for different group sizes but varied significantly with BER, as shown in Table 1.

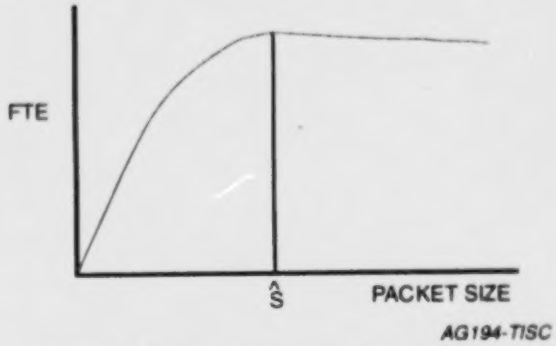

FIGURE 3. PACKET SIZE VS. BER FOR FIXED GROUP SIZE

TABLE 1. PACKET SIZE VS. GROUP SIZE AND BER

BER	Group Size	Range of Optimal Packet Size in Bits	Throughput Efficiency	Expected Number of Retransmissions over the Optimal Packet Size Range
E-3	1	508 - 607	21.9	1.8 - 2.0
E-3	50	382 - 495	6.3	5.1 - 6.0
E-3	100	364 - 508*	5.5	5.7 - 7.0
E-4	1	2230 - 2447	59.6	1.2 - 1.2
E-4	50	1259 - 1414	23.2	2.6 - 2.7
E-4	100	1137 - 1514*	20.4	2.9 - 3.2
E-5	1	7943 - 9174	84.5	1.0 - 1.0
E-5	50	2163 - 2912	43.5	1.7 - 1.8
E-5	100	3737 - 4150*	39.2	2.1 - 2.1
E-6	1	25614 - 27141	94.8	1.0 - 1.0
E-6	50	3835 - 4760	71.0	1.1 - 1.2
E-6	100	2982 - 3592	63.0	1.2 - 1.3

* NOTE: Since all members receive and combine data during retransmissions, the optimal packet size and expected number of retransmissions don't change significantly with group size once the group gets large.

6. SOFTWARE UPDATES

The optimized broadcast file transfer protocol described above is used for distributing software and database updates over the air. The destination for these types of broadcasts is the "NEW" subdirectory at each of the destination suites requiring the update. Facilities are provided at the network control site for commanding the remote site to copy the files in the "NEW" subdirectory to the current active directory and forcing the remote site to resume execution with the new code and databases.

Each time a network member logs into the network, the network controller is automatically informed of the software release level that is active at the remote site. In addition, the forward control channel is partitioned into groups. This partitioning is according to link margin and software release level. While users in a group receive their assignments, the remaining groups have access to the remaining carriers for data communication (see Figure 4). Thus, orderwire groups provide for seamless software upgrades by allowing several software release levels to coexist within the same network.

7. CONCLUSION

An efficient broadcast file transfer technique has been described. A scheme has been derived for optimizing throughput as a function of packet size. This file broadcast technique has been thoroughly tested and is used in a worldwide 82-site narrowband UHF Demand Assigned Multiple Access (DAMA) network as well as a broadband 72-site C-Band network in Thailand.

For large groups, the number of data retransmissions does not increase significantly with group size. Thus this file transfer technique is ideal for broadband data distribution applications such as used in distributing newspaper Sunday supplements where the group sizes are in the hundreds. The file is broken up into packets sized so that throughput is optimized. The packets are broadcast using a broadband SCPC modem. A narrowband TDMA modem at the receiving site is used to provide the required feedback to the broadcasting site.

Since the expected number of retransmissions does not vary significantly with group size, this technique remains competitive even when fiber optic channels are provided as an alternative.

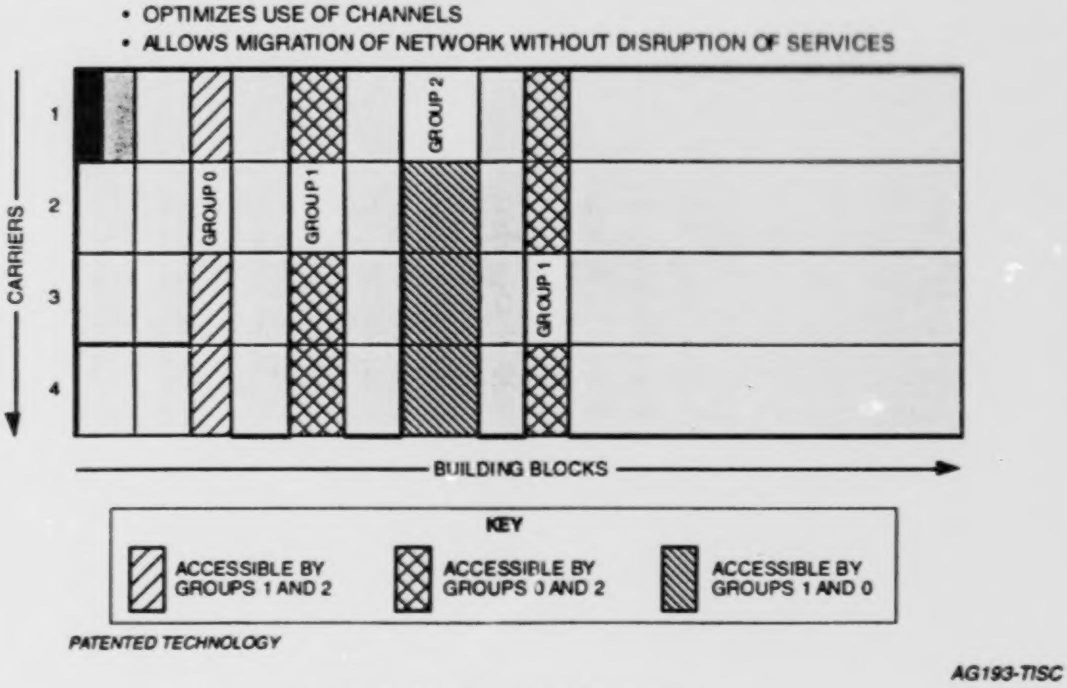
• OPTIMIZES USE OF CHANNELS
• ALLOWS MIGRATION OF NETWORK WITHOUT DISRUPTION OF SERVICES
CARRIERS
1
2
3
4
GROUP 2
GROUP 0
GROUP 1
GROUP 1
BUILDING BLOCKS
KEY
ACCESSIBLE BY GROUPS 1 AND 2
ACCESSIBLE BY GROUPS 0 AND 2
ACCESSIBLE BY GROUPS 1 AND 0
PATENTED TECHNOLOGY
AG193-TISC

FIGURE 4. ORDERWIRE GROUPS

REFERENCES

1. Edson Hendricks,
Synchronous Telecommunication Protocol,
Workshop of Data Communications, CP-76-9
September 15 to 19, 1975,
Institute for Applied Systems Analysis,
2361 Laxenberg Austria.

2. D. Chase,
Code Combining,
MILCOM 84, Vol. 1, 1984, pp. 71-77.

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International Network Planning
In a Changing Environment

Glenn L. Hunger and Arunabha Chatterjee
AT&T
Morristown, New Jersey U.S.A.

1. ABSTRACT

Changes in the international telecommunications environment are impacting the immediate and long-term approaches to planning international networks. The paper presents some of the environmental changes in the industry with respect to regulation, call routing, technology, and strategic alliances. Network planners need to go beyond simple engineering criteria in planning networks, and must incorporate environmental events into strategic planning and implementation considerations. Acquiring information to plan the evolution of bilateral and multilateral networks is a major challenge for the network planners.

2. INTRODUCTION

International network planning is encountering greater challenges due to changes in the global telecommunications industry. With the introduction of new technologies and the entrance of alternative communications providers, the traditional bilateral partnerships between telecommunications administrations are being altered. The existence and growth of multicarriers, resellers, refilers, call back operators, and self-correspondence is a result of the different political, regulatory, legal and business environments across countries. Overlaid on these changes, is the convergence of voice, data and multimedia technologies.

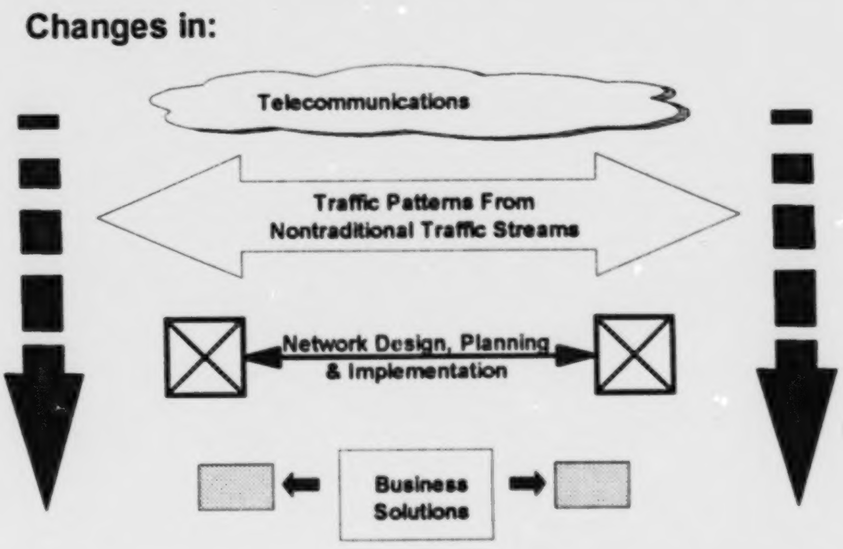
This paper describes the impact of the changing telecommunications environment on international network planning. The expanding participants in the industry and their evolving relationships lend to the specter of an era of transitory networks. The changing networks are based on different strategic intents of the participants and do not readily lend to simple optimization models. The design and planning of networks have become dynamic in nature. Enhanced capabilities in economic optimization and industry information are required to develop network solutions that allow for the use of the telecommunications networks as a strategic capability (see Figure 1).

3. BACKGROUND

International network planning has traditionally been based upon engineering criteria driven by 'steady state' bilateral forecasts and agreements with one Telecommunications Administration (TA) per country. The bilateral networks were mainly designed for voice and voice band data traffic. Low speed data networks existed along with a limited number of international dedicated lines. Since the 1970's facsimile traffic and dedicated lines have grown rapidly. During the last two decades, digital facilities and switches have replaced analog technologies, and have enabled higher speed services and enhanced ancillary support systems.

To leverage the available international capacity, compression technology was gradually introduced into the networks in the 1980's. Growth in the introduction of new services in 1980's required new routing and facility considerations. The late 1980's saw the introduction of new signaling architectures, and the 1990's saw a surge in signaling conversions to CCITT #7.

Figure 1


Changes in:
Telecommunications
Traffic Patterns From Nontraditional Traffic Streams
Network Design, Planning & Implementation
Business Solutions

There also has been an evolution in the delivery systems. The investment in international facility assets has historically been made through worldwide international consortiums (e.g. INTELSAT for satellite facilities) and through regional consortiums for cable systems (e.g. TPC-5). The consortiums have typically composed of one TA per country, and operated on the philosophy of sharing investment costs.

The underlying factors of change in the industry have been the changes in:

1) technology (software - routing, information storage, speeds, compression, signaling, diagnostics ; hardware - VSATs, processors, data storage, SDH rings),

2) political/legal/regulatory (privatization, new entrants as carriers and as information providers),

3) new services (ATM, frame relay, ISDN, etc.),

4) concomitant economic incentives (profit for new entrants and collection rate price wars).

The industry continues to experience high levels of growth across the spectrum of services - from basic voice to virtual networks to the Internet to video-on-demand and to multimedia.

4. INDUSTRY CHANGES

Changes in the international telecommunications environment has its origins in several diverse fields. The changes can be linked, in part, to regulation, call routing, technology, and strategic alliances.

4.1 REGULATORY/LEGAL

Each TA is governed by a legal and regulatory body within a sovereign political system. The purview of customer contacts by the TAs generally has been based upon the customer's geographical location -- where each administration dealt with the customers within their territory.

The market is now entering an age of dynamism with changing legal and regulatory rulings encouraging new facility-based entrants into both the national and international markets. The legalities of resale, refile and call back, vary across countries, but the barriers are falling. Slowly, inroads into the TAs' monopolies are occurring worldwide through legal changes, regulatory rulings, and legislative enactments.

4.2 CALL ROUTING

4.2.1 CALL BACK

Collection rate arbitrage is leading to nontraditional calling patterns as to the origination and termination of calls. Call back operations are being conducted by both companies and individual customers (see Figure 2 for an illustration of the traffic flows). The legality of call back activity varies across countries. One manifestation of call back is an increase in imbalances in traffic flows and the resulting impact on settlement payments. The impact on network planning can be quite significant when considering the following:

- overall call processing time can increase to switch the 'final outgoing call',
- inbound signal processing may be handled by one carrier, but the outbound call transported by a competitor,
- additional resources can be required for support systems (databases, operating systems, etc.), and
- Answer/Seizure Ratios can drop significantly for carriers receiving the incoming ring-no-answer setup calls.

4.2.2 REDIAL

The provisioning of dial tone to an incoming international call enables a customer to connect to another number (see Figures 3 and 4 for an illustration). The call can be connected to parties within the country or to parties in a third country. The redial capability enables the consumer to realize a lower overall charge for the two links of the call compared to a direct call to a party in the third country. It also enables conference calling and for customer billing preferences in managing accounts. The same considerations must be given by network planners as in call back, but now capacity for new traffic terminating in the third country must be planned.

Figure 2
Call Back

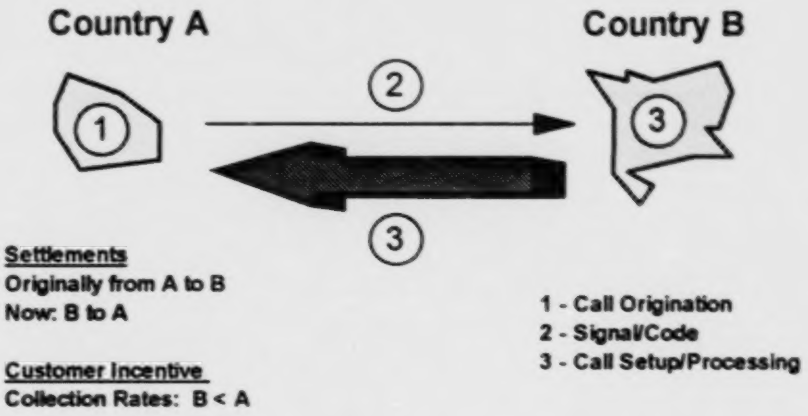


Figure 3
Redial

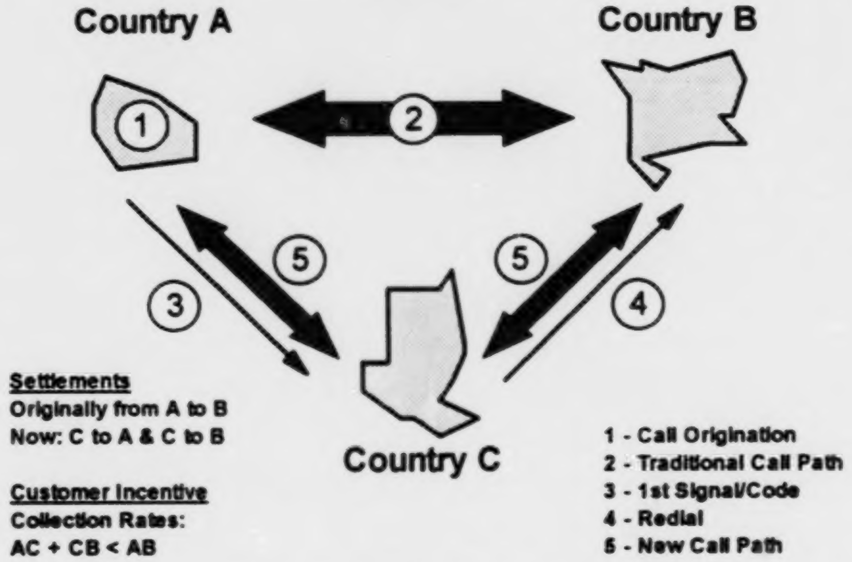
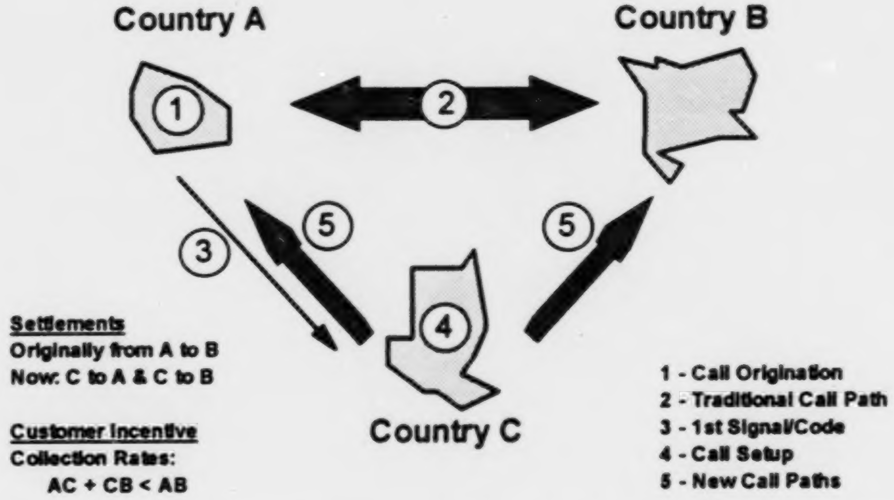

Country A
Country B
Country C
1
2
3
4
5
5
Settlements
Originally from A to B
Now: C to A & C to B
Customer Incentive
Collection Rates:
AC + CB < AB
1 - Call Origination
2 - Traditional Call Path
3 - 1st Signal/Code
4 - Redial
5 - New Call Path

Figure 4
Call Back and Redial


Country A
Country B
Country C
1
2
3
4
5
5
Settlements
Originally from A to B
Now: C to A & C to B
Customer Incentive
Collection Rates:
AC + CB < AB
1 - Call Origination
2 - Traditional Call Path
3 - 1st Signal/Code
4 - Call Setup
5 - New Call Paths

4.2.3 REFILE

Calls originating in one country and switched via another country to terminate in a third country is legal through transiting arrangements with all three administrations. Refile has occurred when the administration where the call originates settles with the intermediate administration (previously the via country and excluding a par cours settlement agreement), and the intermediate country settles with the administration were the call terminates. See Figure 5 for an example of a network evolution from bilateral traffic flows to a mix of bilateral and refiled traffic through a node. Though the discernability of refile is difficult, most TAs are neither conducting nor sanctioning such activity. Refile activity may evolve with the advent of self-correspondence and alliances that loom on the horizon. Movement to refile activities will change the bilateral traffic patterns and, depending on the refilers' tactics, possibly create greater variability in those traffic patterns. Here then is a key linkage between worldwide collection rates and settlement rates across administrations with network planning considerations.

4.2.4 PRIVATE LINE RESALE

Resale of switched voice over private lines is currently limited to a few countries. Whereas resale of data traffic is more open, resale of voice and data is expected to accelerate as markets are opened in the near future.

For those countries allowing resale of private lines for voice traffic, noticeable shifts in cross border traffic onto private lines can occur. Initially, large business customers took advantage of their economies of scale and shifted their traffic. Subsequently, niche operators have entered the market and have targeted smaller businesses and residential customers. An outcome of resale has been the shifting of traffic with greater profit margins to a service(s) with a lower margin(s). International resale is generally prohibited, but customers have been known to 'leak' their private line traffic onto the switched network. See Figure 6 for an illustration of private line resale.

Figure 5
Refile

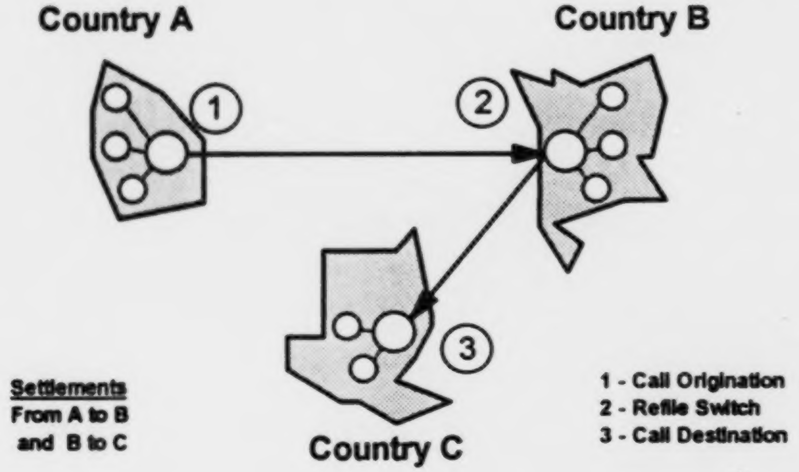
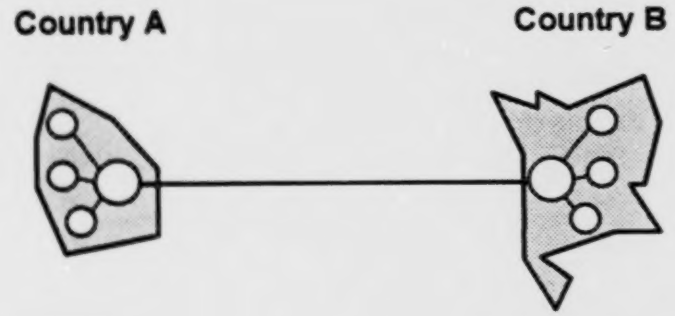


Figure 6
Private Line Resale



Settlements
Originally, switched
traffic from A to B
or B to A
Now: None

Customer Incentive
$A' < A$ or $B' < B$

where A', B' are reseller rates.

4.3 TECHNOLOGY

The industry is experiencing the convergence of voice, data, image, video and multimedia. It is at the beginnings of an evolution toward both transport mediums and equipment which enable the delivery of broadband and multimedia applications. For example, the industry is in the beginnings of experimenting with the Asynchronous Transfer Mode (ATM) platform and its deployment in bilateral networks over the next decade. While growing networks within the existing switching architectures, overlay networks and their new platforms will be introduced to supplant higher cost delivery systems and to enable the delivery of new services. Planners will continue to implement the advances in data compression technology, per call control capabilities and bandwidth on demand to increase the utilization on existing capacity.

Throughout these changes, planners must ensure the interoperability between different platforms and plan for the transition of traffic load from one platform to another. The integration of cellular and PCNs networks is ongoing. LAN and WAN interconnections are occurring, and network management platforms across technologies are becoming critical. Underlying the introduction and transition to a new platform(s) will be an increasing reliance on service specific forecasts.

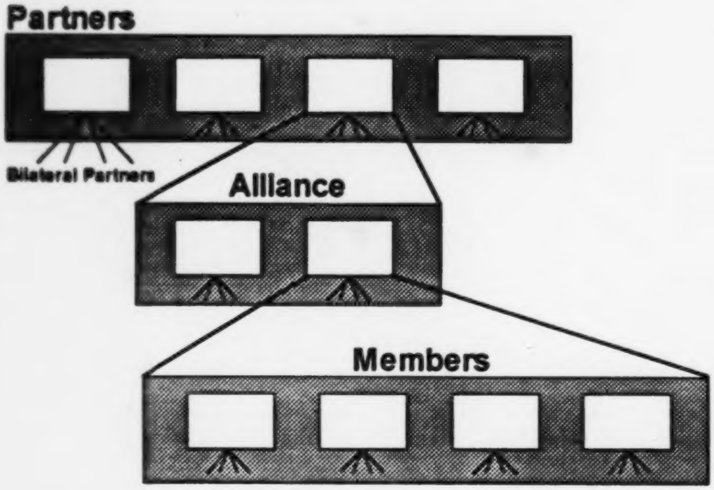
4.4 STRATEGIC ALLIANCES

Recently there has been activity in the formation of strategic alliances, e.g., Unisource, WorldPartners, Eunetcom, and Concert. In part, the alliances are meant to provide integrated solutions to global customers. This integration provides customers with end-to-end services, enhanced capabilities such as broadband and multimedia capabilities, improved service attributes such as mobility (cellular and PCN) and enhanced features (e.g., virtual networks).

Interestingly, no significant changes have been observed so far in bilateral traffic streams with TAs who are members of the alliances. The norm of direct routing of bilateral traffic apparently is being followed. However, alliances can be repositioned for responding quickly to changing market conditions, as well as sending market signals to existing or potential participants in the market.

The industry is now in the initial stages of strategic alliance formation (see Figure 7). The movement may portend bloc alliances in the near future, and the redirection of traffic among members and away from nonmembers.

Figure 7
Strategic Alliances



5. IMPACTS ON NETWORK PLANNING

Network planning now faces environmental changes manifesting in the transition:

- from monopoly to multiple carriers,
- from bilateral partnerships to multilateral partnerships, self correspondence, alliances and joint ventures,
- from 'ownership' of originating and/or terminating calls to a carrier's carrier handling the traffic of resellers, refilers and call-back operators,
- from consortium to private suppliers of delivery systems, and
- new technologies.

Network planning now must account for:

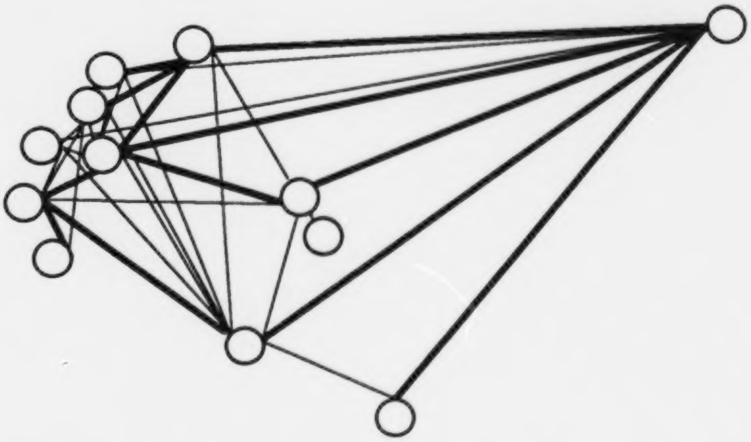
- 'domestic and foreign' multicarriers,
- attempts at end-to-end customer offerings,
- the phenomenon of being relegated to a carrier's carrier,
- the emergence of strategic alliances,
- nodal architectures,
- short term tactical uses of networks,
- transitory networks,
- interoperability across platforms.

Following are some key factors that need to be considered in planning of international networks in a changing global environment:

5.1 OVERSEAS NODES

As strategic alliances evolve, different network arrangements will also evolve. One such evolution is the establishment of a node with a member of an alliance to reroute/refile traffic. The traffic may be routed to gain engineering efficiencies, to circumvent capacity constraints and to reduce settlement outlays. See Figure 8 for an illustration of the existence of bilateral networks and of alliances with regional nodes and varying degrees of traffic intensity.

Figure 8
Bilateral and Nodal Networks

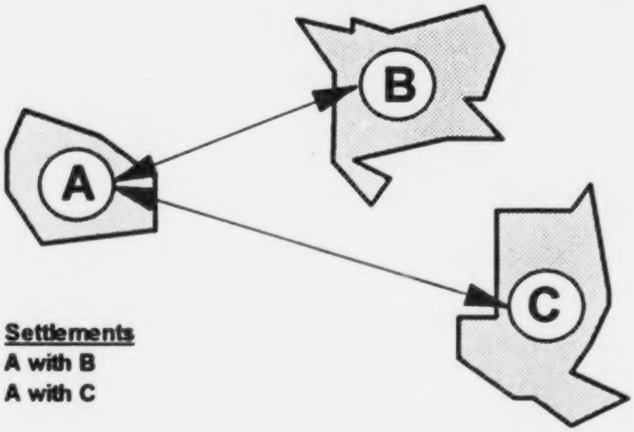


5.2 TRAFFIC BIFURCATION

The industry may see a movement by companies to overseas nodes and/or alliances. With such a deployment of resources, the traffic, or portions thereof, may at first be bifurcated between the traditional bilateral traffic stream and an incremental traffic stream. Such a bifurcation can be based upon financial settlement considerations. The bifurcation of traffic between directly and indirectly routed traffic thereby acts as a tool for strategic positioning vis-à-vis competitors and partners. See Figures 9a through 9c for an example of an evolution from a traditional bilateral arrangement with two partners to an interim step of routing incremental traffic via a node, and finally to a stage where there is no longer direct traffic to one of the partners. Such a final stage would involve game theoretic strategies between existing and former partners in moves and counter moves with respect to the networks, the traffic and the flow of settlement funds.

Figure 9a
Network Evolution

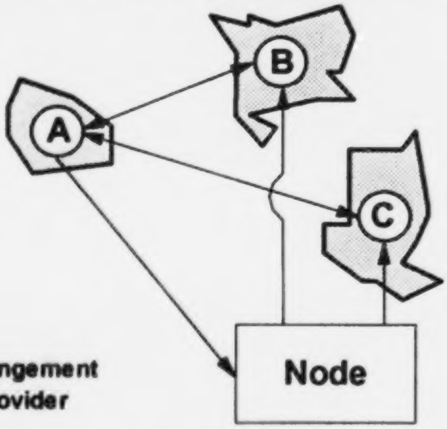
Traditional Bilateral Partnerships



Settlements
A with B
A with C

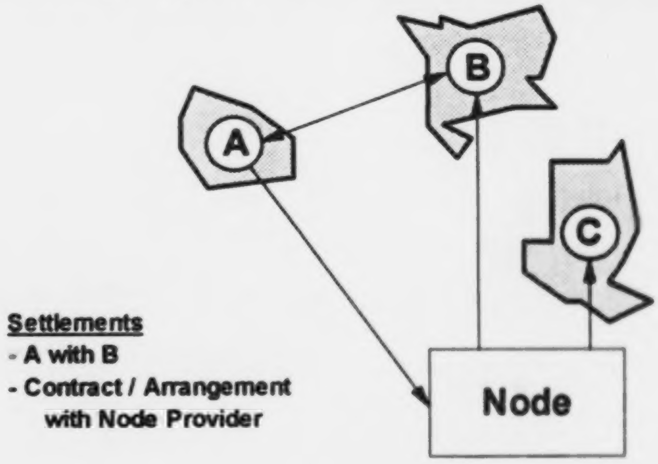
Figure 9b
Network Evolution from Partnerships to Alliances

Bilateral and Incremental Traffic Flows



Settlements
- A with B
- A with C
- Contract / Arrangement with Node Provider

Figure 9c
Network Evolution with Alliances
Bilateral, Incremental and Refile of Traffic Flows



5.3 ONE-STOP-SHOPPING

To provide end-to-end customer service, operating support systems (OSS) may be located overseas. In conjunction with the OSS, switching nodes may evolve to handle large regional traffic streams via a third country. Alliances can link applications (e.g., software), services (e.g., telephony, entertainment) and local, national and international telecommunications providers. Additional possibilities include the end-to-end integration of facility infrastructures and the horizontal integration of applications and services. Current industry developments include a global service provider offering one-stop-shopping through multilaterial alliances with global customer service centers and global work centers.

5.4 NETWORK QUALITY

TAs are pursuing projects to differentiate their networks by quality (e.g. advanced noise reduction techniques, improved BER, response time to customer complaints) and features (e.g. automatic redial upon busy, call return to originator upon successful completion at the foreign end). Competition will also entail network survivability through diversity and restoration planning. TAs not staying within reach of technological improvements for network quality may be relegated to being basic facility providers.

5.5 NEW ENTRANTS AND PROPORTIONATE RETURN

A relatively abrupt change in the level of traffic can occur when new carriers enter into the market. The market share captured by new entrants varies overtime and across countries for a given entrant. Additional network planning and implementation calculations arise in receiving and returning the proportionate traffic to the multicarriers. Furthermore, adjustments to the proportional return factor increase the variability of traffic, which lags the underlying variability of end customer demand by three months or more.

5.6 TRANSIT TRAFFIC

Abrupt changes in the level of switched traffic has been noticed as carriers compete for transit traffic. Bilateral networks have expanded and contracted in accommodating transit traffic and then experiencing its reduction/demise. Transit traffic being routed over different networks due to cost considerations is becoming the norm. Network planning must now account for the increased variability and uncertainty of the traffic and weigh the benefits of over or under provisioning of networks. See Figure 10 for an example of the impact transit traffic may have.

The additional profit from handling transit traffic must be compared to the acquisition cost of additional capacity. Scenarios may be necessary to plan for quick responses to changing traffic patterns. For such just-in-time (JIT) adjustments, capacity management must strive to reduce the cycle time in acquiring capacity. The current arrangement of obtaining permission to transit the third party network as to the time-of-day and volume of traffic may additionally require a planner to consider just-in-time (JIT) switching and routing capabilities.

6. NETWORK PLANNING MODELS AND INFORMATION NEEDS

The traditional approach of planning networks based on engineering criteria is being modified to accommodate economic factors outside of the traditional bilateral engineering considerations.

How does a network planner approach the seemingly increasing chaos of telecommunications events? Key enhancements needed in network planning models are:

- Linkages between engineering criteria for designing networks and financial gains must be strengthened. For multiple services being carried over a common network, business decisions need to consider short and long-run profitability considerations,
- Multilateral network optimization models need to be developed that consider arrangements beyond simple transit,
- Network inventory management tools need enhancements to perform cost analyses,
- JIT planning requires new information collection processes and market intelligence data to discern industry trends. Expert systems are needed to realize JIT provisioning,
- Mechanisms are needed to capture information on market based prices for cable and satellite capacity, in order to support JIT planning,
- Economic criteria are required to allocate limited capacity across services, e.g. voice priority over video.

The need exists for linking the underlying micro foundations of customer behavior to prices, promotions and new services with the macro considerations of economic capacity planning. For example, customer responses to a blocked call may lead: 1) to a retrial of the call, 2) to a lost call to a competitor, or 3) to a lost customer. Additionally, consumer models linking quality of service attributes (such as echo, delay, BER, and mean-time-to-restore), to incremental profitability analyses are necessary.

Finally, introductions of new services and technologies over a common network require risk analyses on: (i) switch and facility failures, (ii) satellite restoration or cable-on-cable restoration, (iii) the prioritization of services given limited capacity, and (iv) the long run profitability across services.

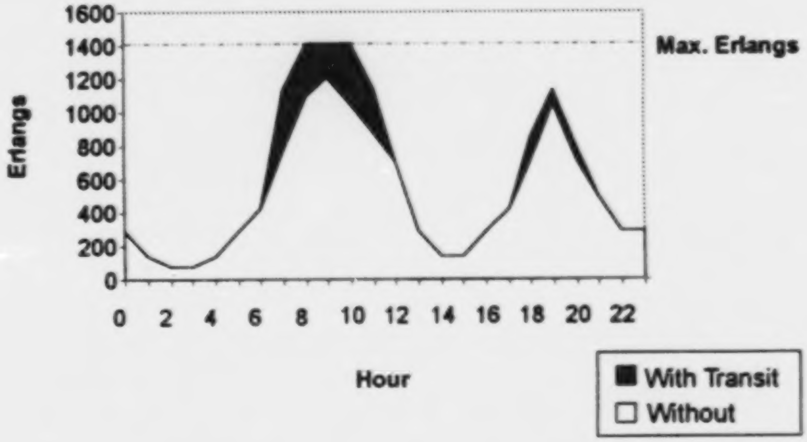
7. CONCLUDING PERSPECTIVES

The industry is composed of individual, unpredictable, interacting customers being supplied in the past by bilateral and generally predictable telecommunications partners. Now some of the partners are becoming competitors as well as suppliers, while still maintaining their partnering relationships. Furthermore, alternative carriers are entering the market. Within this environment, greater uncertainty has arisen in planning for specific routes. Currently, an increasingly in the future, network planners need strategic planning capabilities to analyze existing environmental events and trends. Acquiring the information on the evolution of bilateral and multilateral networks and the responses of customer actions is a major challenge for the network planner.

Network planners must be ahead of the information curve in acquiring environmental information, and using the knowledge from the

Figure 10

Time-of-Day Traffic Distribution With and Without Transit Traffic



information in formulating network planning strategies and tactics in concert with the company's business direction. The quality of network planning solutions is now dependent upon the intelligence of timely information to facilitate the management of switch and facility capacity across telecommunications administrations.

As the information for network planning grows in complexity, the required information systems themselves become complex and may be beyond our individual understanding of their strengths and weaknesses. Nevertheless, the planner needs real-time information in planning networks. An upcoming challenge is to incorporate and translate information into intelligence and finally to enable the translation of the intelligence into predictable solutions. Caution is in order as to how resources are devoted to the task. To paraphrase Fransico Antonio Doria, "in attempting to bring order to the complexity, we must be careful not to evolve to perplexity" (1).

REFERENCES

(1) "From Complexity to Perplexity," John Hogan, Scientific American, June 1995, Pages 104-109.

Strategic network challenges: The case of public network planning and practice in Thailand

Robyn A. Lindley¶ and Liaquat Hossain*

¶Information and Communication Technology Department
University of Wollongong, Wollongong 2522, Australia

*Faculty of Business Administration,
Assumption University, Bangkok, Thailand

1. ABSTRACT

The overall aim of this paper is to analyse the relationship between strategy and organisational structure for telecommunications planning and development in Thailand. It begins by evaluating the development of Thailand's present infrastructure and planning practices. It also discusses key strategic planning factors which will contribute to the changing function of Thailand's network. We have identified significant shortcomings and conclude that there is an urgent need for sectorwide strategic planning to be given a higher priority.

2. INTRODUCTION

Strategic network planning and the development of an appropriate implementation program for telecommunications infrastructure development is increasingly becoming a rapidly changing activity. For almost every nation, the difficulties of achieving a best fit between anticipated demands for local and international public telecommunications traffic and infrastructure - and the available resources - requires a special consideration. For rapidly developing nations such as Thailand, inadequate telecommunications infrastructure and limited resources, the choice becomes even more difficult. It is also understood that investment in telecommunications infrastructure has long been an important key to the economic development of a country or geographic region. In addition, the total investment in network expansion will represent a considerable proportion of the GDP for many economies. The successful delivery of a world class telecommunications infrastructure can act as a catalyst to increase trade opportunities and to enhance other economic activities and social functions.

For developing countries like Thailand with rapidly developing economies, the planning and implementation approaches adopted will be a key factor in both facilitating and shaping economic cooperation and development in the years ahead. At the level of the technology, these changes mean that there is an increase in the complexity and diversity of networks. As a new player, Thailand is now in a position to instantly adopt the latest technologies and quickly add new network services such as videoconferencing or cable TV onto the primary network.

Together, these observations call forth and highlight new strategic challenges for the Thai telecommunications industry. It is against this backdrop that this paper seeks to identify and evaluate possible key strategic factors which will contribute to the changing function of Thailand's network in the years ahead. The primary goal was to determine the relationship between strategy and organisational structure for telecommunications in Thailand. The paper also includes a summary overview of the development of Thailand's telecommunications infrastructure and planning practices in the context of TOT's corporate business vision.

3. THAI TELECOMMUNICATIONS DEVELOPMENT

Historically, telecommunications infrastructure development has played a key role in the development of Thailand since the deployment of the first public telegraph service in 1875 (1). A brief chronological history is provided in Table 1. As in most nations, Thai telecommunications history has been largely been directed under the influence and control of various government agencies. At present, telecommunications development is under the control of three organisations: the Post and Telegraph Department (PTD); the Telephone Organisation of Thailand (TOT); and, the Communications Authority of Thailand (CAT). PTD is responsible for policy rules and regulation , CAT is responsible for the operational control of international services and TOT for domestic telephone services. Whist CAT and TOT are state enterprises and PTD a government department headed by a director general, all three organisations answer directly to the Ministry of Communications which is also responsible for transport.

On March 28 1995, the Thai Cabinet finally unveiled its long awaited plan to privatise parts of the two major state-owned monopolies of CAT and TOT. However, it is still unclear just how quickly the Thai government plans to privatise TOT and CAT. From the little that has been revealed about the plan, initially it is likely that TOT and CAT will each be divided into two separate companies: The first of each will remain under state ownership and control; the second will be sold on a joint-venture basis with the government retaining a 49% share of each. Of the remaining 51%, 2% will go to Thailand's Crown Property Bureau, and no more than 30% will be held by a single private organisation, while foreign ownership will be limited to 20%. However, there is no time frame for the partial privatisation process proposed.

1875	First telegraph service
1881	First telephone service
1883	Postal Department and Telegraph Department established
1897	Postal and Telegraph Departments combine to become the Post and Telegraph Department (PTD)
1931	First private citizens' radio station
1936	First long distance telephone service (to Tokyo)
1954	Telephone Organisation of Thailand (TOT) established
1963	First international telex services (to Japan)
1966	Thailand became a member of Intelsat with a 0.1 percent share
1971	First radio paging service
1972	First car phones installed
1976	Communications Authority of Thailand (CAT) established
1979	First facsimile transmission service
1984	Thailand's share of Intelsat increased to 0.49 percent and GTE international was contracted to build the earth station near Bangkok
1991	Shinawatra was given a 8 year monopoly contract to launch Thaisat for television, government and domestic communication needs, as leases expire on other satellite systems
1995	First privatisation plan announced

Table 1. A brief chronology of Thai telecommunications development

As can be gleaned from the above brief historical overview, overlapping functions have been a key feature characterising the telecommunications history in Thailand. However, in recent years, increasing responsibility for telecommunications activities has been transferred by the PTD to TOT and there is now a growing commitment to the future privatisation of the Thai telecommunications industry. It is now agreed by the Thai telecommunications sector - both public and private - that the time is now right to give telecommunications strategic planning a higher status as both a state and as a process.

3. KEY STRATEGIC THRUSTS OF THE THAI GOVERNMENT

At present two major strategic thrusts are governing the evolution of Thailand's telecommunications services: The first is to decrease the subscriber waiting list to a point where demand can be met in as short a time a possible. The second involves a program of upgrading network infrastructure to optimise the flexibility and cost, and to increase the range of services available.

To date, the privatisation of national telecommunications services has not been a priority - despite the announcement of the intention to do so. Rather, further centralisation of management, planning and operational control has been the key strategy adopted to improve the overall approach to strategic planning for the year 2000 and beyond. Yet in noting this, and in view of the challenges to be highlighted in the proceeding section, it is recognised that no single methodology is generally applicable for upgrading telecommunications infrastructure in a particular national setting (2). It is therefore essential for Thai agencies responsible for the development of strategic national telecommunications planning to establish clear policy guidelines and to make preparations well in advance. The announcement of plans to privatise telecommunications in March 1995 was the first step in that direction.

Collectively, the actions of previous Thai governments have reflected a belief that privatisation of telecommunications services is the best policy option to cope with the rapid economic growth of the country and as a means to procure the large financial resources required to extensively develop the infrastructure and to keep pace with new technological developments. Yet, in practice Thai fixed-line telecommunications services are not expected to be privatised for several years. An explicit policy of the Thai government is to strengthen TOT until it is ready to be able to compete commercially with private companies while still ensuring that it retains its role as the nation's leading telecommunications service provider. To help to achieve this aim, the specific policy objectives of TOT can be summarised as follows (TOT Annual Report 1993):

(i) establish a base that will enable TOT to compete in a competitive environment;

(ii) rapid expansion and modernisation of the network to meet social and economic demand;

and,

(iii) build up internal expertise and unity among TOT employees.

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4. WHAT ARE THE MAJOR CHALLENGES TO BE ADDRESSED?

In practical terms, and in view of the policy objectives summarised above, the immediate challenge for Thai telecommunications strategists is to recreate the role of the internal management arrangements, and to align its regulator and organisational structure with the strategic mechanisms now in place. However, there remain a number of identifiable constraints to further network expansion that need to be addressed so as to ensure that the strategic objectives highlighted above can be achieved within a limited time frame and with existing resources. These can be broadly categorised as follows:

(1) rapid economic growth
(2) privatisation policy development
(3) infrastructural leapfrogging
(4) eliminating large subscriber waiting lists
(5) producing data for accurate demand forecasting
(6) developing technological know-how

RAPID ECONOMIC GROWTH

Thailand is conveniently located in the world's fasted developing geographic region. Thailand's economy has also experienced strong economic growth in recent years in comparison the OECD nations. In the period from 1988 to 1992, the GDP continued to grow at an average of around 16%, while maintaining a comparatively low level of inflation (3). Despite the prolonged recession experienced by most nations in the early 1990s, Thailand and its Asian neighbours have continued to show robust economic growth (4).

However, there has also been an increase in international borrowings to cover the cost of infrastructural development needed to maintain the current rate of economic development. In particular, this means that huge investment in telecommunications infrastructure is now required. Total investment in network expansion in Thailand from 1993 to the year 2000 is forecast to be in excess of US$5.5 billion. In addition, telephone demand for 1993 was around 3.5 million lines and this is expected to increase to 5.5 million lines by the year 2000. The Thai government recognises that the total financial and resources investment demands required will be far greater than any previous development plans.

At present, one of the more urgent challenges to be addressed is in Bangkok. The Bangkok area has an inadequate telephone system for its relative size and international importance. Bangkok has an important international airport and many leading international firms have a presence in the Bangkok area. Another major problem is the difficulty of encouraging infrastructural development in the provinces.

The expectation of the Thai government is that privatisation will encourage foreign investment and soft loans for infrastructural development. Yet the Thai government has been slow to commit to a time frame for privatisation.

PRIVATISATION POLICY DEVELOPMENT

Although committed to the expansion of public utilities and infrastructure, Thailand's previous Anand Government rejected the idea of privatisation on the basis that it could be used as a political tool for politicians to profit through corruption during the bidding process.

However, the Anand I Government, shortly after it took power, decided to review the role of privatisation. It also reviewed the three-million-line telephone project granted by TOT to TelecomAsia, controlled by the Charoen Pokphand (CP) Group. This resulted in splitting the contract between two companies: The first is with the CP Group (since renamed TelecomAsia), and comprising the development of a two-million-line telephone network to service Bangkok. The second was awarded to the Loxley-Jasmine consortium's Thai Telephone and Telegraph Co. (TT&T) to provide an additional one million lines for the provinces. Telecommunications services are being made available in the metropolitan and provincial regions and access rates do not vary significantly throughout the country even though the services may be provided by different companies or using different technologies. Unfortunately, the decision by the government to review contracts already granted, as well as others, have had the result of undermining the trust of the private sector in the Thai Government's ability to honour contracts (5). Thai politics has also been notoriously unpredictable in the past.

The Chuan Government, has continued to accept the previous government's "spirit of privatisation". It is also recognised by the Chuan government that the underlying demands, trends and growth prospects need to be examined so that a major program of infrastructural development can be implemented to catch up with demand and to influence future socioeconomic growth development patterns and directions. According to the Deputy Prime Minister, Dr Amnuay, privatisation has now become an economic instrument for infrastructure development; as well as the mechanism for a restructuring of management strategies to increase efficiency and to strengthen private leadership in the process of national development (6). Yet, despite the Chuan government's effort to work toward the development of policies that demand a greater input from the private sector, private investors are still not confident in the governments stance in honouring contracts with private investors. Private telecommunications organisations in Thailand have also been encouraged to work towards the establishment of international telecommunications projects. Ventures with Cambodia and Laos have now begun and there are plans for joint ventures with nearby Myanmar and Vietnam.

Another privatisation strategy identified is to allow more players to come into new telecommunications industry sectors. Thailand has recently increased the number of cable TV franchises to seven. The privately owned companies, UCOM and Advanced Info services, operate the two most successful Thai cellular networks

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(7). However, it should also be noted that although the Chuan government have increased the number of opportunities by awarding more licences, they have not yet relaxed licensing conditions such as network build-out and investment requirements.

INFRASTRUCTURAL LEAPFROGGING

Rapid modernisation and expansion of Thailand's infrastructure is a key strategic objective. Yet, many of the poorer countries of Asia like Thailand, are fortunate that they have lagged so far behind in the provision of telephone services in the sense that they can immediately adopt new technologies and a high level of services which are similar to those now in use in developed countries. However, whilst such technological leapfrogging can offer new opportunities, it also presents some additional challenges that need to be considered.

New cellular networks can now be deployed with less time and money than conventional fixed-line systems. For example, after the Cambodian peace accord, Ucom of Thailand was able to set up a basic cellular system in Phnom Penh within six weeks. For this reason, the International Telecommunications Union (ITU) has estimated the mobile phones will outnumber fixed units by 1997 in Thailand (8). In addition, TelecomAsia is now deploying a state-of-the-art fibre optic digital network within the Bangkok expansion plan which is capable of supporting a whole new range of services. Services currently in the planning stages include interactive shopping, interactive entertainment, videoconferencing/video telephones, remote medical diagnosis, EDI services and distance education.

TelecomAsia is shifting from the existing switching plan which is designed to support more than 75 exchanges and many RSUs and is adopting a more concentrated approach. The switching hierarchy approach adopted relies on new switching technology and up to 9 switching sites. The capacity to be installed at each Centralised Switching Node (CSN) in the network will cater for a potential 2 million lines. Each CSN consists of a number of 60,000 line capacity Group Switching Processors (GSPs) that are fully interconnected with each other and integrated with TOTs existing crossbar tandem exchange as well as the newer digital tandem exchange networks. Access to the CSNs is facilitated by a transmission network of fibre optic Customer line Interface/concentrator units - sometimes referred to as Remote Concentrator Units (RCUs) - which form the front end part of the switching system. The new network is being installed as on overlay to that of the existing TOT network and thus offering maximum flexibility in distribution and switching capacity.

However, this strategy is also not without its difficulties. Replacing electromechanical telecommunications networks with digital technology requires very high levels of investment largely because there are many incompatibilities between old infrastructure and new technologies and therefore need to be deployed in full blocks. Given that switching equipment represents one of the most expensive elements of new digital networks in terms of capital costs and ongoing running costs, centralisation offers a better utilisation of resources. In this case, the benefits of a more centralised network have to be weighed against the risks it presents. The failure of a large CSN can isolate whole communities. In Bangkok, this risk has been reduced by parenting concentrators on to different processors and by ensuring that there is adequate built-in redundancy and recovery facilities available (9).

NUMBER OF YEARS TO ELIMINATE WAITING LISTS

The idea of a "telephone on demand" also appears to be the key strategic objective that is hoped to be achieved in as short a time as possible. At present Telephone line penetration in Thailand is low. There are only about 3.1 telephone lines per 100 people and in Bangkok alone and there are more than 1 million names in the waiting list of the Telephone Organisation of Thailand (10). This mismatch between the demand for telephone services and the ability to keep pace means that the demand for mobile telephony and paging services has been boosted. Yet despite this, the cellular penetration is also still low and was estimated by Pacific Link in Hong Kong to be 0.72 in 1994 (11).

The 2 million lines to be installed in Bangkok by TelecomAsia and the 1 million lines to be installed in provincial areas by Thai Telephone and Telecommunication (TT&T) will increase the number of lines to about 8 per 100 people. Both TelecomAsia and TT&T are confident that they can complete their current contracts by 1996. In addition, the Telephone Organisation of Thailand itself, plans to install a further 1.1 million lines in order to achieve a penetration level of 10 lines per 100 people nationally under the current five year plan ending in 1996. However, in April 1994, the line penetration was still less than 5 lines per 100 people. It is believed that because the government is now under pressure to allow other companies into the telecoms market, it will soon ask TelecomAsia and TT&T to waive their 5-year protection rights banning other companies from installing any new lines in current areas granted concessions. These protection rights are due to expire in 1997 for Telecom Asia and in 1998 for TT&T.

It is estimated that Thailand will need to install 13.5 million lines by the year 2001 to meet the projected demand (12). In fact, the ITU has estimated that based on recent growth rates in main lines, the long waiting lists will not be eliminated until around the year 2000 (13). This forecast could also be unrealistic as further economic development will result in a rapid increase in the number of lines required per 100 people. The penetration level forecast of 9.35 for the year 2000 (14) may in fact be well below the demand levels necessary to sustain further economic growth as businesses themselves become more dependent on a range of telephony and information services.

From an economic perspective, there is also pressure from Asia Pacific Economic Cooperation (APEC) economies for Thailand to achieve a national penetration level of more than 20 lines per 100 people. Thailand will not be able to become an APEC member until this level is achieved.

DEMAND FORECASTING

One major difficulty with accurately forecasting demand for new services is the lack of relevant historical and technical data required by the quantitative approaches normally used. In an environment where the technological, and socioeconomic parameters are all rapidly changing, the problem becomes more complex. As a consequence a wide range of methodologies have been adopted by some developing nations (15). In the case of Thailand too, the ability to demand forecast will be of strategic importance and will depend on a supply of accurate data - in conjunction with the development of appropriate national economic forecast scenarios. This will involve a range of methodologies and input from market information, penetration rates and economic predictions on the demand side. On the policy driven side, this will involve the identification of the effects of policy on demand and the stimulation of new service utilisation. Price capping measures for example, may significantly influence demand.

DEVELOPING TECHNOLOGICAL KNOW-HOW

Another key challenge identified is the need to develop essential *know-how* to meet ongoing operational and service requirements for major new infrastructural projects. In particular, digital switching equipment and fibre optic transmission technology know-how are becoming essential to meet the anticipated demand for higher bandwidth and more specialised services such as EDI. This is a difficult challenge for most developing countries as nearly 90% of all telecommunications equipment which forms the technological and economic core of public telecommunications infrastructure, is produced in OECD countries (16). Consequently, most developing countries like Thailand have adopted policies to encourage the involvement of major international telecommunications companies in local infrastructure development.

The ability to act effectively will also depend upon the co-development of other core technology related competencies. In particular telecommunications software and systems engineering relating directly to the provision and maintenance of competitive and efficient services. These core competencies are now considered by the Thai government to be so important that it is essential that they are developed - at least to some extent - within Thailand rather than relying on outside suppliers. Universities such as Bangkok's Assumption University, are at present planning the introduction of new telecommunications degrees to increase both the number and range of formal telecommunications courses available in Thailand. Such course development will also serve as a basis for future R&D programs that will help to undergird the future development of national telecommunications infrastructure.

5. THE FUTURE

Planning under conditions of complexity, uncertain economic forecasts, imperfect information and working under the changing views of political representatives, the present Thai government has no alternative but to limit its longer term strategic planning to the construction of visions in deciding what future moves they should make. These visions are not merely the result of processing information received from the environment within which they operate. It also involves interpreting information based on beliefs and historical factors. It is these visions that allow an organisation to envisage the future and therefore decide what actions are to be taken.

Although nowhere explicitly stated, the vision of Thailand's telecommunications future embodies the following elements: The first essential element of creating future strategic visions is the establishment of sufficient lines so that demand can match supply in as short a time as possible. Second, the key force driving the future competitiveness is the introduction of competition. Third, most financial, technological and human resources will be supplied by international firms who are encouraged to have a presence in Thailand through concessions. It is also anticipated that competences related to improved competitiveness and returns will also be delivered by cooperation with international telecommunications firms. Finally, and as a way of avoiding excessive reliance on foreign transnational corporations, the development of indigenous telecommunications firms is encouraged through the government bidding process favouring local tenderers.

To date, Thailand, has not undertaken a comprehensive telecommunications sector reform approach. Instead, it has taken a series of tentative steps has been taken towards opening up the local telecommunications industry to private investment. However, because of the continued poor performance of CAT and TOT, pressures for reform based on privatisation policy have increased in recent years. Such outlooks are also supported by external views based on the experiences of other developing countries. In a report released by the Word Bank that synthesises lessons of experience of special relevance for Asia's developing countries, it is concluded that government support for monopolies based on arguments of economies of scale and scope is not a valid one (17). One of the main concerns it raises is the ability of the telecommunications sector of developing nations to keep pace with the region's growth and expansion. It is argued that many nation's have already paid dearly for the limited attention accorded to the telecommunications sector in the past, and the socioeconomic costs associated with apparent inefficiencies of state owned and operated telco. The inability to meet underlying demand, is a crucial problem which will impact future economic growth.

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At a more general level, we believe that collectively, these developments have highlighted the urgent need for sectorwide strategic planning and the parallel development of an appropriate sectorwide legislative regime to manage and control the future directions of Thai telecommunications so as to ensure that the key strategic objectives can be achieved with a given set of resources, and within the time frame required. A clear statement of the strategic objectives and of the future roles of the principle public and private players is what is now needed. We propose that strategic implementation requires a fit between strategy and telecommunications infrastructure design and implementation. This means that strategic planning must be viewed as both a process and a state: It involves a dynamic and interactive search that seeks to align the local telecommunications industry with its environment. This means identifying and aligning the available resources internally to support the external and more competitive stance of the national industry infrastructure. In practical terms, strategy becomes the basic alignment mechanism and the internal arrangements are organisational and regulatory structure and management processes. Although this approach is expected to be applicable for many nations, this analysis suggests that the alignment is critical and more difficult to gauge for rapidly developing nations such as Thailand.

6. CONCLUDING REMARKS

The primary emphasis of this analysis was to determine the relationship between strategy and organisational structure for telecommunications in Thailand. It is presupposed that the regulatory systems in place are needed to link public objectives and concerns with private incentives (18). While the strategy-organisational structure was highlighted, evidence for supporting the longer term strategic goals of Thailand was found to be limited. Yet, current changes in the telecommunications industry are offering rapidly developing nations like Thailand unprecedented opportunities and change affecting social, cultural and economic activities.

With the complexity and forecast growth of the Thai telecommunications industry, the study of strategic planning issues has become extremely important. Most telecommunications organisations, are operating in markets where competition is rapidly intensifying as both the range and number of competitors is increased. To succeed in these markets, small developing nations must successfully implement strategic planning strategies to provide them with socioeconomic advantages.

We conclude then, that strategic planning as defined in the preceding section is crucial for Thailand. We have identified possible areas of concern and conclude that the time is also now right to give strategic planning a higher status as both a state and as a process. In practical terms, to recreate the role of the internal management arrangement of TOT and aligning its regulator and organisational structure with the strategic mechanisms in place is now the challenge. Whether the strategic stance presently being adopted by the Thai government will be functional, in the sense that it will aid future economic growth in an increasingly complex operating environment, or will be the source of significant shortcomings is a crucial question, the answer to which will only emerge in the years beyond 2000.

REFERENCES

[1] Charmonman S. 1994. *Telecommunications in the Pacific Basin: An evolutionary approach*, Oxford University Press, 201-216.

[2] Hoshi M., C. Yiannakou, A. Sanati and M. Ghazal, 1992. ISDN introduction planning in developing countries: CCITT GAS9 case studies. Proceedings of SUPERCOMM/ICC'92, *Discovering a new world of Communications*, New York: IEEE, June 1992, 2:1732-1736.

[3] Mytri P. 1993. Mild recession or gentle recovery? *Bangkok Post*, July 19 1993: 11.

[4] Asian Development Bank 1994. *Asian Development Outlook 1993.*, Asian Development Bank, Manila: Oxford University Press, April 1993.

[5] Chantranontwong P. 1992. Investing to close income gap. *Bangkok Post*, December 31, 1992: 42-43.

[6] Chantranontwong P. 1993. Privatisation to remedy congestion. *Bangkok Post*, July 19 1993: 33.

[7] Parker P., A. Owen and M. Kelly 1995. Financing new telecommunications systems as competition increases. Proceedings of the *Pacific Telecommunications Council Seventh Annual Conference* (PTC'95), Honolulu, Hawaii, January 1995: 661-665.

[8] Clifford M. 1994. Pressure for change: Technology brings a wide array of growth options. *Far Eastern Economic Review in Asia*, April 7, 1994: 36-55.

[9] Vimolvanich V. 1992. Bangkok network expansion project. Proceedings of the 1992 ISS *International Switching Symposium*, Yokohama, Japan, October 25-30, 1992: 102-105.

[10] Fairclough G. 1994. Thailand: Markets and magic. Far Eastern Economic Review, April 7 1994: 41.

[11] Clifford, Op. Cit.

[12] Vatikiotis M. 1995. Alarm bells: Thai telecoms privatization plan worries private sector. *Far Eastern Economic Review*, April 20, 1995: 72.

[13] Clifford, Op. Cit.

BEST COPY AVAILABLE

[14] ITU Report 1994. *World telecommunication Development Report: World telecommunication indicators*, Geneva: ITU.

[15] Hoshi, Op. Cit.

[16] Antonelli C. 1991. *The diffusion of advanced telecommunications in developing countries*, Praxis: Development Centre of the Organisation for Economic Cooperation and Development Centre, Washington DC: OECD.

[17] Smith P. L. and G. Staple 1994. Telecommunications Sector Reform in Asia: Toward a new pragmatism. *World Bank Discussion Papers* (232), Washington DC: The World Bank.

[18] Sinha N. 1995. Regulating telecommunications in developing countries: an institutional analysis. Proceedings of the *Pacific Telecommunications Council Seventh Annual Conference* (PTC'95), Honolulu, Hawaii, January 1995: 370-377.

End-To-End Multimedia Service Management Enabling Collaboration In A Distributed Enterprise Environment

Miyuki Sato, Kiyoh Nakamura
FUJITSU LIMITED
2-15-5 Shimokodanaka, Nakahara-ku, Kawasaki 211, Japan
Sharad Kumar, David Liu, Rao Mikkilineni
NETWORK PROGRAMS, Inc.
255 Old New Brunswick Road, N320, Piscataway, NJ, 08854 USA

1. ABSTRACT

With the advent of new low cost desktop switching through ATM(Asynchronous Transfer Mode) network, the complexity of the network and hence high operation cost can be reduced by providing voice, data and video over ATM and Synchronous Digital Hierarchy(SDH)/Synchronous Optical Network(SONET) network. In this paper, we present Inter Domain Manager(IDM) that is a key concept in the end-to-end multimedia service infrastructure and an environment for necessary service management that allows real time associations between the consumers and the resources.

2. INTRODUCTION

Global competition is forcing today's enterprises to optimize their enterprise-wide resources and reduce time to market in order to meet the market place demands. Timely enterprise-wide information access and cross functional work-group collaboration are becoming critical to be competeive. Some of the enterprises are connecting their world-wide operations using high speed networks to access large volumes of R&D data for quick consumption. Others are providing important information often in multimedia formats in a timely fashion to people that need it. Few are even attempting to exploit quality video conferencing among work groups that are geographically distributed. In most of these cases, the change to high speed networks is evolutionary from their current low speed voice and data networks.

With the advent of low cost desktop switching through Asynchronous Transfer Mode (ATM), enterprises are beginning to consider private network solutions even before public ATM backbone becomes available to meet their immediate needs. Figure 1 shows the rapid drop of cost per port versus time that is a major factor contributing to this trend. In addition, the possibility of a single network that can carry voice, data and video is attractive because it will be simpler and cheaper to operate and manage. Figure 2 shows a recent comparision of different networking technologies in the enterprise.

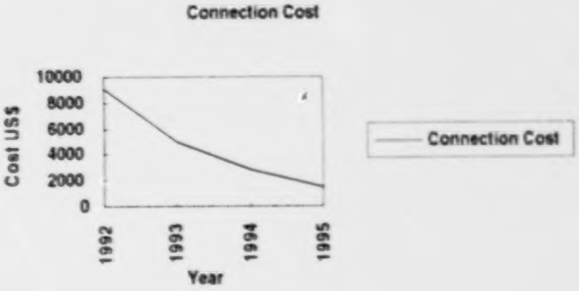


Figure 1 DROP OF COST PER PORT

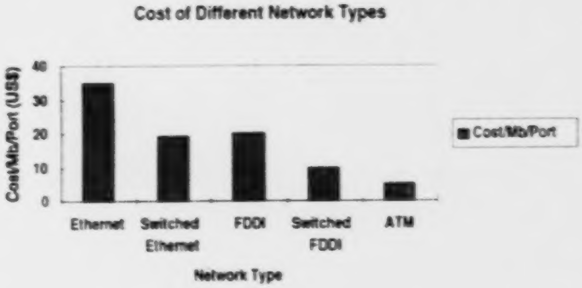


Figure 2 COST OF DIFFERENT NETWORK TYPES

The trend clearly shows that ATM technology is becoming competitive when costs are considered. Possibility of a private switched video network that can also provide data and telephony at no extra cost offers efficiencies through bandwidth management on demand. It becomes even more attractive if the operation and management costs are also reduced using such a network. However, there are few obstacles to deploying such a video network today:

- Today's multivendor ATMs do not inter-operate and it is difficult to provide end to end service applications enterprise-wide while integrating the computing environments with existing Local Area Networks (LAN).

- Reliable service architectures do not exist that can support multiple services enterprise-wide like video conferencing, "drag and drop" file manipulation capability across the network and multimedia information on demand on the same platform.

- Multiple service applications are difficult to implement because no service programming interfaces exist that will allow these applications to collaborate with each other. For example, video conferencing application working in concert with application supporting remote file access through "drag and drop" facility.

- It is difficult to implement a private switched video network to the desk top because bandwidth and resources for on-demand applications can not be easily managed today.

In order to take advantage of the new ATM technology and provide a simpler to manage, high speed switched network to the enterprise desk top, some key service integration issues have to be addressed through software.

In this paper, we present an attempt to address some of these issues. First, we will describe a prototype architecture that allows integration of multiple network domains in the enterprise including ATM, Synchronous Digitial Hierarchy (SDH)/ Synchronous Optical Network (SONET), video server and Legacy LAN networks. Using this architecture, end-to-end services are provided across the network using the services provided by an Inter Domain Manager(IDM). This provides an immediate solution to connection management across not only heterogeneous ATM switching equipment but also across different network domains. In addition, the IDM provides an Application Program Interface (API) for developing end-to-end network and service management applications that will support an end-to-end switched network to the desk-top. We are using this prototype to study the end-to-end network and service management reqirements for ATM based enterprise networks.

3. END-TO-END MULTIMEDIA SERVICE INFRASTRUCTURE AND ENVIRONMENT

3.1 SERVICE INTEGRATION ARCHITECTURE

Figure 3 shows the required interconnectivity in an enterprise that promotes collaboration and information sharing among the people independent of geography.

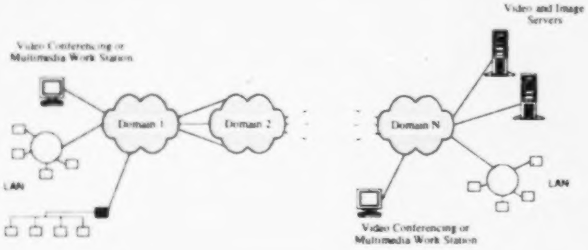

Video and Image Servers
Video Conferencing or Multimedia Work Station
Domain 1
Domain 2
Domain N
LAN
LAN
Video Conferencing or Multimedia Work Station

Figure 3 ENTERPRISE NETWORK MODEL WITH MULTIPLE DOMAINS

With the advent of ATM, there is a possibility to transform today's shared type of network to switched network using bandwidth management. This not only allows the optimal use of shared resources in an enterprise through bandwidth on demand but also allows the consolidation of voice, video and data traffic on a single network. Such a switched network to the enterprise desk-top can provide economies of management while allowing interactivity and collaboration among the participants across the enterprise. Some of the examples include:

- Sharing files and data across the enterprise with "drag and drop" capability from any desk-top to any other desk-top.

- Establishing on demand connectivity across multiple paticipants to support collaboration applications independent of transport technology used or the heterogeniety of the network.

Figure 4 shows a typical heterogeneous, multi-domain enterprise-wide network. The wide area network connectivity can be provided by private lines using, SDH/SONET, Frame Relay , or through a public switched network.

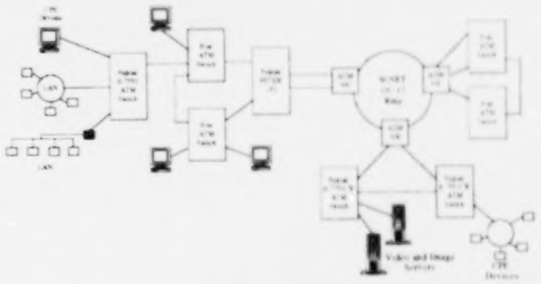


Figure 4 **EXAMPLE OF HETEROGENEOUS AND MULTI-DOMAIN ENTERPRISE-WIDE NETWORK**

In order to provide a switched network from desk-top to desk-top, a software service architecture must support this network where multiple software applications can provide different end-user services like video conferencing, LAN interconnectivity etc. In addition, this service network must be reliably operated and managed at a reasonable cost. Figure 5 shows such a software service architecture.

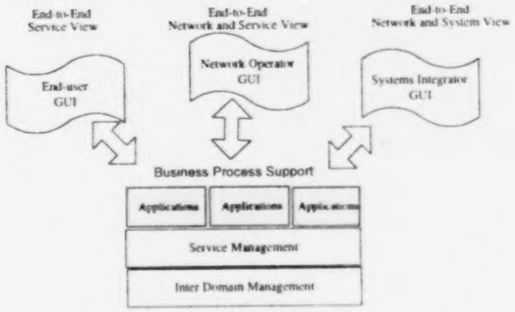


Figure 5 **SERVICE MANAGEMENT ARCHITECTURE**

This picture represents three different views namely, end user view, system operator or manager view and a systems integrator view. In an enterprise, multiple applications usually supports a business process. The applications in turn utilize various end-to-end network services to provide the required functionality.

From the end user point of view, the following services are required:

- Support for existing workgroup applications across multiple domains transparently (e.g., video conferencing)
- Support for access to remote information easily ("drag and drop" across domains)
- Integration of video, voice and data call setup for information on demand

From the network operator (manager) point of view, the following services are required:

- Provide service visibility needed to manage the network
- Allow local network re-configuration
- Support retrieval of usage information for application development
- Provide network management for multi-vendor equipment
- Support Graphic User Interface (GUI) for service & network management

From the Systems Integrator or Service Planner point of view, the following services are required:

- Support installation of both network and service management applications
- Define generic Inter Domain and Local Domain management interface to facilitate integration of new domains easily
- Define a feature-rich Service Management interface (provided by API) to support service development
- Support local and inter domain services that can accomodate multiple technologies and different vendor equipment

In addition, multiple applications must coexist and cooperate in order to fully integrate the operation and management of the network and various services provided by these applications. This is accomplished by providing an Inter Domain Manger(IDM) that offers application services for common service, session and connection management across the network.

In order to realize above requirements for end-to-end services, proposed infrastructre in Telecommunications Management Network(TMN)[1] is shown as Figure 6.

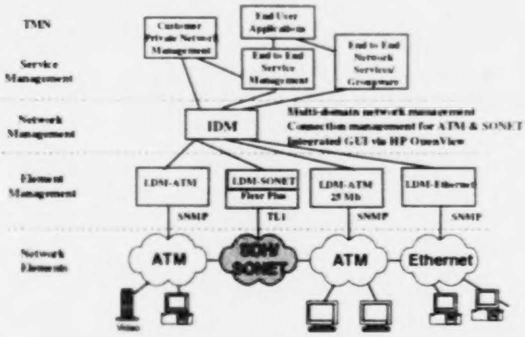

TMN
Service Management
Network Management
Element Management
Network Elements
Customer Private Network Management
End User Applications
End to End Service Management
End to End Network Services/ Groupware
IDM
Multi-domain network management
Connection management for ATM & SONET
Integrated GUI via HP OpenView
LDM-ATM
LDM-SONET
Fiber Plus
LDM-ATM 25 Mb
LDM-Ethernet
SNMP
TL1
SNMP
SNMP
ATM
SDH/ SONET
ATM
Ethernet
Video

Figure 6 INFRASTRUCTRE FOR MANAGING END-TO-END SERVICES

The infrastucture consists of the following elements:

- 'A Local Domain Manager(LDM) allows provisioning and management of local resources, auto-discovery of network inventory, processes traps, maintains routing table for connections in a single domain, and responds to requests from the Inter Domain Manager (IDM).

- An Inter Domain Manager (IDM) allows integration of multiple domains, technologies, and heterogeneous vendor elements by interacting with LDMs. In the near-term it will address interconectivity issues across heterogeneous ATM switches and in the long term (when signalling is standardized across multivendor switches), it will still provide integration of multiple domains and technologies. In addition to this, IDM provides feature-rich Service Management interface (provided by API) to service management applications.

- Service management supports generic service provisioning, service negotiation, multimedia data management and GUI by interacting with IDM through Service Management interface (provided by API). Service management applications are the applications which provide service-specific network partitioning and provisioning, dynamic reconfiguration, real-time fault management,real-time billing necessary for distributed enterprise environment.

In following sections, Service Management Functions, IDM, Service Management Applications, Example Imformation On Demand Applications will be decribed.
In the current prototype, we have included mlti-vendor ATM's along with Ethernet. However, the SDH/SONET domain will be investigated in the future[2][3][4][5].

3.2 SERVICE MANAGEMENT FUNCTIONS

Required functions for service management which collaborates with Inter Domain Manager(IDM) are as follows.

- Resource and network configuration for new network

- Service negotiation and provisioning for new user

- Multimedia DataBase(DB) access on-demand

- GUI for system initialization, inter-domain network management, and system testing

Resource and network configuration functions are required to configure resource and network for a new network and to input configuration information to an inventory database. Service negotiation function is required to negotiate with new subscribers in order to create a service contract and to support customer services on different type of networks, such as Private Network (PN), Virtual Private Network (VPN), Public Network. Necessary functionalities for each network are as follows.

For PN:

To allocate dedicated physical facilities for user's bandwidth-critical application

For VPN:

To guarantee bandwidth for VPN subscribers and phisical facilities to be shared by multiple VPNs

For Public Network:

Analogous to Plain Old Telephone Service (POTS), on-demand, sharing facilities, bandwidth availability not guaranteed, using with VPN and PN for overflow

Multi media (MM) DB access on-demand function is to support on-demand access to Multi media(MM) DB from desktop and to provide VPN/PN routing based on customer's contract. GUI allows collaboration between IDM and inventory DB and allows easy-to-use interface for system initialization, inter-domain network management, and system testing.

3.3 INTER DOMAIN MANAGER

The Inter Domain Manager (IDM) which collaborate with service management and collect necessary information from Local Domain Manager(LDM). It is designed to:

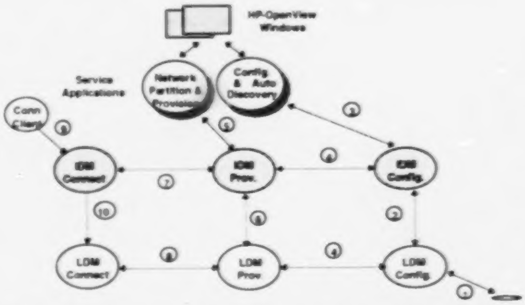
- Coordinate services across domains
- Establish and maintain agreed upon Virtual Path Identifier (VPI)/Virtual Channel Identifier (VCI) values across inter-domain points
- Contain no detailed knowledge of any particular domain
- Provision and monitor connections across inter-domain points
- Provide end-to-end routing across domains

IDM provides above functions and manages configuration/ fault/performance/accouting/security necessary for service management based on the information which is exchanged between LDM and the IDM. For example, routing service to select optimal path through lines from the cost, speed, resource points is very important customer to avoid loss of business opportunities. IDM decide routing path from the end-to-end point of view and agreed upon VPI/VCI valus across inter-domain points and establish the connections. In adiition, these functions can be accessed from the service management layer through Service Management interface(provided by API).

LDM:

Each LDM is designed to provide and manage resources in a single domain, to process traps in a single domain and relay filtered traps to IDM, to maintain routing table for connections within domain and ingress and egress points of the domain, and to take appropriate action to IDMs connect or disconnect request.

3.4 SERVICE MANAGEMENT APPLICATIONS



① Read static config. info for the domain from the DB
② Pass LDM topology info to IDM with gateway points
③ HP-OV Apps request IDM & LDM config. & topology info
④ IDM Prov requests config. info for inter domain
⑤ Network patitioning for VPN/PN and public networks
⑥ LDM patitioning for VPN/PN and public networks
⑦ IDM Prov. passes public network info to IDM Connection
⑧ LDM Prov passes Public network Info within local domain
⑨ Connection request from a client application
⑩ Connection request with gateway points if needed passed to LDM Conn

Figure 7 SERVICE MANAGEMENT APPLICATIONS

Figure 7 shows the process flows of service management applications collaborating with Inter Domain Manager(IDM).
The service applications implement the following:

- Request local & inter domains configuration data from IDM Configuration

- Build & maintain HP-Open View object database
- Display network configuration maps
- Receive network change notifications & update maps
- Allow network operator to monitor entire network & query data for any network elements
- Customizable to provide Customer Network Management view

This environment for service management allows associations between the consumers (e.g., the end customer) and the resources (e.g., the switch and other network elements being used to provide the service). This ability allows to provide network partition & provision, auto discovery & dynamic reconfiguration, real-time network trouble shooting, and real-time billing services using above process flows.

3.5 EXAMPLE INFORMATION ON DEMAND APPLICATION

Using the Inter Domain Manager, a service application is created that allows information from a video server to be accessed from any desktop in the network. In addition, "drag and drop" capability is demonstrated from any desk-top to any other desk-top. The network consists of three different vendor ATM switches providing connectivity to desk-top using both Unix and Windows based workstations. Establishing on demand connectivity across multiple participants allows "applications to support collaboration among work groups in an enterprise-wide network". Video clips/Graphics for news, stock informaion are some of the example applications.

These applications are developed using a methodology that allows process definition and corresponding software application development. The development process consists of the following[6]:

- Define Process flows & System requirements
- Represent Process flows & Annotations
- Create Information flows
- Idetify Objects and Services
- Capture Dependencies
- Implement as Object Oreiented Development Method

4. LESSONS LEARNED

Some of the lessons learned from our prototype are as follows:

- Keeping track of real time associations between resources, service objects and consumers allows real time fault management and dynamic service management.
- Auto discovery of network configuration can be easily supported by taking advantage of the services provided by intelligent network elements and their element management systems. This feature helps address some of the database sysnchronization problems between customory provisioning systems and the real network configuration. As the network changes in real-time, this information is captured through appropriate traps and communicated to appropriate service applications to update the topology and configuration information.

5. CONCLUSION

The main purpose in this paper was to describe a prototype architecture that helps to build an end-to-end service's infrastructure using an Inter Domain Manager (IDM) in a distributed enterprise to make multimedia services available. By providing real-time information, intelligent network elements like ATM, SDH/SONET, video server etc. allow a new class of reliable operation and management services to support enterprise-wide media services. By taking advantage of these features, we can provide transparant access of information across the enterprise, facilitate collaboration through multimedia applications and improve reliability and cost effectiveness of the communication network. The same architecture with the concept of the Inter Domain Manager may be extended to include other networks such as Hybrid Fiber Coax or ATM to home applications. For such applications as video on demand to home, present architecture allows real-time billing, real-time fault management and customer care applications.

ACKNOWLEDGEMENTS

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REFERENCES

[1] CCITT Draft Recommendation M..3010, "Principles for a Telecommunications Management Network," 1990.

[2] Network Management Forum, "OMNIPoint : Strategic Framework, " 1993.

[3] Network Management Forum, "A Business Strategy : Implementing TMN Using OMNIPoint," 1994.

[4] T. Miyazaki et al., "Dynamic Operation and Maintenance Systems for Switching Networks,"IEEE Communications Magazine, Vol.28, No.9, 1990.

[5] Y. Kajitani et al., "Migration to Integrated Network Management," PTC'95, pp.531-536.

[6] R. Mikkilineni, S. Saigal, " A way to create Re-engineering efforts by implementing busines processes as distinct objects in an object network", Patricia Siebold Conference, April 1995.

A New Approach to Procurement Practices for the Undersea Cable Industry

Dr. Y. Niiro
Kokusai Denshin Denwa
Tokyo, Japan
and
S. W. Dawson and J. Roberts
AT&T
Morristown, NJ USA

Abstract

Representatives of the undersea fiber-optic cable industry have worked over the past months on a plan for improving and streamlining the procurement process for submarine cable systems. The growth in the complexity and number of such systems demanded by the marketplace requires a new approach to procurement practices. This new approach will result in reduction of costs for both owner and supplier through streamlined, but thorough, documentation and in an improved overall procurement process. Key to the process is a focus on customer requirements and on satisfying the information needs of the owners.

This paper will report on the evolution and content of this effort.

Introduction: The Need to Revise the Process

In the beginning, there were only a handful of undersea cable system owners and system vendors. Therefore, documentation required to award the technology development and installation of a cable system was often simple and focused. As the industry evolved, the number of system owners and vendors has increased considerably.

As the market has evolved, technology has become more complex, and the asset value of undersea submarine cable systems has increased tremendously. Under these circumstances, all parties feel a great need to protect themselves in the procurement/bid process. All of this has resulted in extensive and complex documentation for Requests for Quotation (RFQ) and the subsequent responses.

An illustration of the complexity of the procurement process is that, some recent bids have required written clarifications of upwards of 500 questions for a single proposal *after tender submission*. The act of drafting and responding to RFQs, evaluating responses, and eventually awarding contracts has become a very difficult, expensive, and lengthy process. The extensive documentation that makes up the RFQ requires the review of an army of specialists before an appropriate response can be framed. Thus, the complex RFQ generates an even more complex and cumbersome bid document of questionable quality, produced within a less-than-desirable lead time, enumerating details that are seldom critical to the decision-making process.

Where do these complex RFQs come from? A review of their contents over the years suggests a process in which RFQ writers take previous documents as a base and then add incremental requirements specific to the project at hand without necessarily excising irrelevant requirements. Rather than debating and resolving the relative values of specific requirements within the scope of an individual project, RFQs tend to reflect all possible requirements of various interests within the owner's organizations. Adding more conditions to an RFQ turns out to be a simpler, safer, and quicker action than eliminating unnecessary requirements.

RFQs also reflect today's ways of doing business. A substantial portion of each RFQ is dedicated to protecting the owner against undesirable events usually related to the reliability of the equipment or installation. Obviously, the more innovative the technology, the more protection is sought. Further, submarine systems are major investments, and their downtime can lead to losses in revenue compounded by high costs to restore service. Thus, a limited warranty period would leave the owner vulnerable to significant losses. Conversely, suppliers need to protect themselves against exposure to the adverse consequences of such assurances. Hence, the extensive protections sought by both parties can lead to lengthy RFQs, lengthy responses, and protracted contract negotiations.

Complex RFQs, extensive non-critical detail, expensive and overly detailed proposals, and protracted negotiations add up to significant delays and expenses added to the costs of designing, delivering, and implementing an undersea fiber-optic cable system. A simpler and faster procurement process could result in unnecessary costs trimmed from the process and from the product as well as earlier project implementation. Ultimately, this will lead to faster realization of revenues from the new system.

Objectives and Anticipated Benefits of Simplification

The Procurement Process Simplification Project began with the idea that taking a fresh look at the process would uncover a different way of doing business. The project involved exploring simpler steps from RFQ preparation through the award of a supply contract for a repeatered system. The possibilities considered included offering a system with a warranty that covers its design life and which would make much of today's documentation unnecessary. It looked at simplified requirements that could provide new opportunities for suppliers to minimize the total cost of the system over its useful life through creative designs and new and more effective installation procedures. For example, a longer route that might be more expensive in terms of wet plant could be less prone to accidents and more reliable overall. This should result in more economical operations with lower long-term maintenance costs. When the RFQ is not so complex and constrained as those commonly issued today, it will provide an opportunity to propose economical solutions that satisfy the owner's real requirements without sacrificing system reliability or exposing either the owner or the supplier to needless economic risk.

This RFQ simplification exercise had three fundamental objectives to derive specific benefits:

- Simplify the procurement process to reduce costs for both owners and suppliers.
- Develop standard requirements for marine installation, commercial terms and conditions, and technical specifications.
- Develop a model RFQ having universal applicability to all owners and suppliers in the industry.

Simplification of the procurement process requires scrutiny of each element of the RFQ. Elements should be measured in terms of their relevant value to the project. Using this yardstick, it may be possible to eliminate many questions which ask for marginally relevant detail.

The goal of developing standard requirements in three specific areas will help avoid protracted explanations and negotiations over protection against losses due to reliability issues.

Achieving these objectives will refocus the RFQ on the requirements important to the system's owner rather than continuing to include requirements that follow format rather than function. Achieving these objectives will generate these benefits:

- Lowering the cost of preparing RFQ documentation by using a core package for constant details, leaving only project-specific requirements to be drafted with each new RFQ.
- Defining a core package of requirements through the use of standardized terms and conditions for proposals.
- Lowering the cost of evaluating tender offers by reducing the resources required for detailed analysis and adjudication of the suppliers' responses.
- Lowering the cost of adjudicating tender offers by reducing negotiation meetings between owner and supplier, and simplifying issues to be negotiated.
- Reducing the total price of the submarine system due to reduction in costs allocated to both the suppliers' and the owner's simplified procurement process.

Method of Approach

The team approached the Procurement Process Simplification Project with a sense of "why." The team looked at the some of the most egregiously complex recent RFQs with one simple question: "why?". In all, the project reviewed more than 20 RFQs for major systems issued over the past 15 years and where available the respective responses.

In analyzing these documents, several patterns emerged. In many instances, questions or responses appeared to be in conflict with each other within the same document. Further analysis of these apparent contradictions generated three possible explanations:

- An item was included in the RFQ because it had been included in previous RFQs. The project team was able to track a number of paragraphs that seemed irrelevant to the project at hand across several generations of RFQs. This was evidence of growth of RFQs by accretion.
- Items appeared in RFQs to cover unseen eventualities. The team found a great deal of evidence of "what if" projections in which the authors of the RFQs tried to anticipate and avoid future conflict. The team found that these items would be better accommodated through clearer statements of performance objectives than through prescriptive statements defining methodology.
- Other items appeared to cover details based on obsolete or uneconomical technology. Again, this prescriptive approach to the RFQ seems to do a disservice to all parties involved in the procurement process. In the extreme, it can raise costs significantly and create less than satisfactory solutions.

This analysis of current RFQ trends created a rich resource of specific problems to resolve or avoid in creating a model RFQ document. It also provided a context in which the project team could measure its efforts.

Drafting the Model RFQ

The Procurement Process Simplification Project then took on the task of drafting a model RFQ document. The total process of analyzing the problems inherent in current working RFQs and resolving those problems through the creation of a model RFQ took almost one year.

As the draft model document stands now, it includes language intended to promote a collaborative relationship between the system owner and the winning contractor. This is intended to reduce any vestiges of an adversarial relationship, and enable all parties to work as a productive team with a common goal. Although team building is beyond the scope of the RFQ, the RFQ documentation can create a negative environment erecting almost insurmountable barriers to collaboration; conversely, it can also create a framework for collaboration and success.

In addition to creating the environment in which a positive owner/supplier relationship can develop, the model RFQ identifies specific standards in the areas of marine installation, commercial terms and conditions, and technical specifications.

Standardizing many aspects of marine installation not only helps create a level playing field for all competing bidders, it also helps protect the owner against the results of incomplete or unsatisfactory marine installation methods. The model RFQ requires all contractors and subcontractors that bid on the marine installation components of a system to accept these standards. By so doing, there will be less of a need to detail their approaches to the elements of marine installation covered by the RFQ. Nonetheless, they are still free to propose the application of specific standards and customer methods to satisfy the requirements of the project at hand.

Commercial terms and conditions also outline the rights and obligations of all parties to a submarine cable system project: owner, primary contractor, subcontractors, and suppliers of specialized products and services. These standards provide the kind of universal protection for all parties that will enable the industry to move forward rapidly, responsively, and responsibly in building the global infrastructure for the information age. Issues covered in the commercial terms and conditions section of the model RFQ include:

- Warranty
- Terms of Payment
- Termination.

Technical specification standards also reduce the content and preliminary work that have gone into RFQ preparation and response. Although specifications will vary to support the needs of the owners and the scope of the project, expressing them consistently in standard terms eliminates many questions. Consistent presentation of technical specifications will help reviewers and adjudicators analyze competitive bids quickly and effectively. They will be able to compare competing offers side-by-side without resorting to subjective judgment or interpretation of dissimilar items.

Important Benefits Achieved Already

Compared to the hundreds of pages that make up many recent RFQ documents, the model RFQ is less than 150 pages. Even in accommodating system specific requirements it would seldom grow beyond 200 pages.

More important than the size of the document is the reduction in costs and increases in productivity and quality this model RFQ will generate. Fewer pages and questions will reduce the level of work and required resources on all sides. Because fewer resources need be allocated to each phase of the procurement process, the participants can anticipate an improved quality of responses to RFQs. Overall, these benefits will promote real economies and quality improvements.

Next Steps: Acquiring Assent

1. Seeking Industry Buy In

The team responsible for analyzing the current Procurement Process and drafting the model RFQ is now engaged in the process of seeking acceptance of the concept from industry users located in various regions around the world. Once these users understand and accept the model RFQ, they can influence their counterparts throughout the industry. This is the first step in the diffusion model in which new concepts go through four phases: demonstration, trial, acceptance, and widespread use. The goal in this process is to make the model RFQ an industry standard.

2. Trials in Upcoming Projects

Once key users understand and accept the model RFQ, the next step is trial on an actual system procurement. Although the Procurement Process Simplification Project team is confident that the model RFQ will produce substantial improvements in the process, until it is actually applied and tested with a working project, the real benefits of this project will not be known. At this time, the team has begun to contact the owners of projects to be announced for tenders over the next twelve months.

The team is committed to working with these key customers to adapt the model RFQ to their needs. As it is applied to those projects, the team will measure:

- Reduction in RFQ preparation time and costs
- Reduction in response preparation time and costs
- Reduction in evaluation and adjudication time and costs
- Improvement in contract negotiations
- Improvement in project costs for wet plant, projected life-of-project maintenance costs, or reductions in costs of warranties and other assurances
- Improvement in owner/supplier relations
- Improvement in quality/technology enhancements
- Reduction in design and implementation time measured from deadline for tenders.

Although no trial of the model RFQ has been confirmed to date, the Procurement Process Simplification Project team expects to announce trials within the next several months. The results collected from these trials will then be used to refine the instrument further. In fact, the model RFQ is intended to be the centerpiece in a dynamic process that helps keep the procurement of undersea cable systems fresh and economically productive for years to come.

3. Industry Standard

Once this model RFQ has been officially trialed and modified the team intends to launch an industry-wide communication effort to promote further use of the new procurement tool. The goal of the team is to make this tool an industry standard.

Conclusion: Moving the Global Undersea Cable Industry Forward

The global submarine cable industry is a dynamic partner in the development and evolution of the worldwide information network. Present procurement processes have become detrimental to developing the most cost-effective and technologically appropriate solutions. Processes currently in use are counterproductive because technological change is accommodated through addenda rather than systematically, and because they tend to focus on process prescriptions rather than on desired outcomes. Reforming the procurement process through the creation of an improved and standardized model RFQ will help achieve both cost savings and quality improvements. AT&T and KDD have accepted the challenge of drafting such a model. Today that model RFQ is ready for the industry.

Publishing this draft of the model RFQ represents an important first public step in an ongoing process. The authors of the model RFQ recognize the need for review and comment from the industry. By approaching the Undersea Cable Procurement Process as an industry-wide project, the entire industry stands to benefit.

FSA-10G Large Capacity Submarine Optical Amplifier System and Upgrade Trials for the Future

Masaki Amemiya and Yoshiaki Sato*
NTT Optical Network Systems Laboratories, Kanagawa, JAPAN
NTT Network Systems Development Department, Chiba, JAPAN*

1. ABSTRACT

This paper describes the design concepts and the key technologies of the FSA-10G optical amplifier submarine system that achieves the highest capacity in the world, up to 60 Gbit/s, with long repeater spacing (100 km), and the performance of a commercially installed FSA system. The FSA-10G system is characterized by the following technologies: (1) optical filtering, (2) dispersion management, (3) automatic output level control, (4) multi-system accommodation (6 subsystems), and (5) sophisticated supervisory and accurate C-OTDR fault location. Future trends in submarine transmission systems are also discussed based on the trial test results of applying WDM and optical soliton technologies to the installed FSA system.

2. INTRODUCTION

Optical amplification is a potential key technology in realizing simple and economical transmission systems. Moreover, considering the outstanding features of optical amplification such as transparency to bit rate and modulation format(1), there is the possibility of creating new network architecture.

Among the many applications of erbium-doped fiber amplifiers(EDFAs), the post transmitter amplifier is effective in improving system economy because it allows the repeater spacing to be significantly increased. In NTT's terrestrial SDH network(2), a 160 km long-span, 600 Mbit/s transmission system using EDFAs as post amplifiers has been in use since 1994.

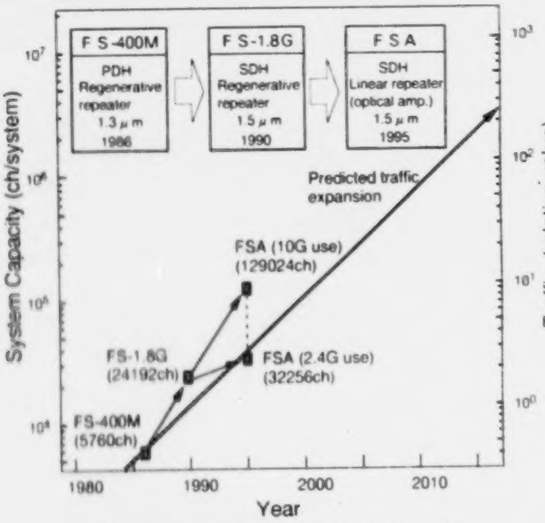


Figure 1. Progress in optical submarine transmission systems and traffic trends

For submarine transmission systems, most research effort(3)(4)(5) concentrated on the in-line EDFA, since this type makes it possible to create networks that are simple, economical, reliable and flexible.

The progress in NTT optical submarine transmission systems is shown in Fig.1. FS-400M and FS-1.8G systems with regenerative repeaters were developed to meet traffic demands. Considering the traffic expansion trend(6) toward the future broad-band network, it is necessary to realize much higher speeds (larger capacity) and much more system flexibility with in-line amplifiers.

This paper describes the design concepts and the actual performance of the highest capacity fiber submarine amplifier system "FSA"(7). The transmission bit-rate of the FSA is flexible and can be 600 Mbit/s, 2.4 Gbit/s, and 10 Gbit/s(8). Future submarine transmission networks are also discussed based on the trial results of applying WDM and optical soliton technologies to the commercially installed FSA-10G system.

3. SYSTEM CONFIGURATION

3.1 FSA System Outline

FSA system parameters and the FSA system configuration are shown in table 1 and figure 2, respectively. The main features of the system are as follows:[1]The transmission bit rate can be flexibly set to either 600M, 2.4G or 10Gbit/s. [2]Up to 6 systems can be supported in the FSA repeater housing. Therefore, 60Gbit/s transmission is possible. [3]Remote in-service monitoring of repeater performance is possible. Moreover, fault location with 1km accuracy is achieved by coherent optical time domain reflectometry(C-OTDR)(9) to determine cable break.

To achieve features [1] and [2], (1)optical filtering is used to suppress the accumulation of optical noise. (2)Fiber dispersion is also managed to avoid fiber non-linearity degradation. In this technique, the total zero dispersion is set around the signal wavelength, 1552nm, in order to avoid wave form degradation. (3)The repeater output is automatically held to 6dBm. The combination of these techniques allows the FSA repeater spacing to become 100km. (4)Multi-system accommodation technology was developed using the low power consumption of EDFAs and monolithic SV-ICs. As a result, FSA repeater size is the same as that of the FS-1.8G, but twice as many subsystems are supported.

	FSA	FS-1.8G
Transmission bit-rate	600M, 2.4G, 10Gb/s (STM-4, 16, 64)	1.87 Gbit/s (STM-12)
Maximum capacity	60Gb/s (10Gb/s×6 systems)	5.6Gb/s (1.87Gb/s×3 systems)
Repeater spacing	100km (at system length : 1000 km)	100km
Optical signal wavelength	1552±0.1nm	1550±10nm
Optical bandwidth	Adjustment by optical filtering in repeaters (FWHM:10nm)	
Optical output	+6dBm [EDFA automatic level control]	-1.7dBm
Supervisory Fault location	· In-service performance monitoring · C-OTDR fault location	Out of service performance monitoring (Loopback)

Table 1. FSA system parameters

To realize item[3], (5)the techniques of optical signal low frequency modulation and high sensitivity coherent-OTDR were developed.

The line signal is transmitted by direct amplification in each EDFA to compensate fiber losses. Supervisory terminals (SV terminals) act as regenerators for the line signal and add/drop multiplexers for the supervisory signal. The optical parameters of the received line signal from terrestrial SDH equipment were modified to suit the submarine repeater requirements, and factors such as optical power, wavelength allowance, and chirping were adjusted. The optical parameters of the received line signal from the final submarine repeater were modified for terrestrial SDH equipment.

The supervisory signal for in-service performance monitoring is transmitted by over modulation of the line signal. The operation system, called MARINE, controls and monitors the performance of submarine repeaters through the SV terminals.

3.2 Line Signal Transmission and FSA Submarine Repeater

3.2.1 Optically Amplified Transmission

Unlike regenerator systems where transmission penalties are reset at each regenerator, impairments accumulate along the optical amplifier chain in FSA. Main causes of transmission degradation are the accumulation of ASE(amplified spontaneous emission) noise, excess intensity noise induced by FWM(four-wave mixing) between the signal and ASE noise, and waveform distortion in combination with SPM(self-phase modulation) and GVD(group-velocity dispersion). Beside these, PMD(polarization mode dispersion), PDL(polarization dependent loss) and PHB(polarization hole burning) are important factors especially with very long transmission distances.

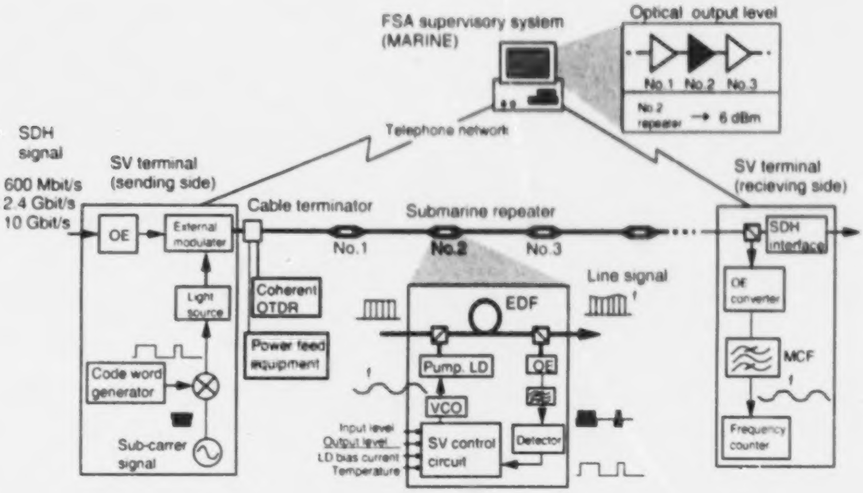

FSA supervisory system
(MARINE)
Optical output level
No.1
No.2
No.3
No.2 repeater → 6 dBm
Telephone network
SDH signal
600 Mbit/s
2.4 Gbit/s
10 Gbit/s
SV terminal (sending side)
OE
External modulater
Light source
Code word generator
Sub-carrier signal
Cable terminator
Coherent OTDR
Power feed equipment
Submarine repeater
No.1
No.2
No.3
Line signal
EDF
Pump. LD
VCO
OE
Detector
SV control circuit
Input level
Output level
LD bias current
Temperature
f
SV terminal (recieving side)
SDH interface
OE converter
MCF
Frequency counter

Figure 2. FSA system configuration and supervisory system

The power penalty caused by these factors depends on optical output power, chromatic dispersion coefficient, fiber nonlinear coefficient, repeater spacing, transmission distance and so on.

The most fundamental factors limiting transmission performance are the ASE noise generated from each EDFA which degrades the signal to noise ratio (SNR) and the waveform distortion caused by SPM & GVD(10).

3.2.2 ALC and Optical Filtering in FSA Submarine Repeater

The configuration of the FSA submarine repeater is shown in Fig. 3. Each repeater contains 12 EDFAs to form 6 line pairs. Each EDFA has a noise figure of about 6 dB and an optical output power of 6 dBm which is set by the automatic level control circuit(ALC). The FSA submarine repeater signal output power level is set over 5.5dBm to maintain the required SNR for 1,000 km transmission with 100km repeater spacing. The level should be less than 6.5dBm to suppress the fiber non-linearity(SPM) induced by high signal intensities.

A 10 nm bandwidth optical filter is located at the output end of each EDFA to remove unwanted ASE noise and to limit the EDFA's gain dependency on wavelength. The optical amplified bandwidth is specified with the mask as shown in Fig.8.

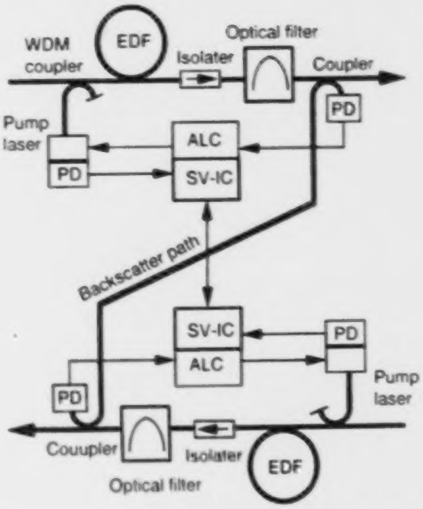


Figure 3. Configuration of FSA submarine repeater

3.2.3 Fiber Dispersion Management

To overcome the excess intensity noise induced by FWM, careful dispersion arrangement is necessary(11) (12). The FWM effect is significant when the signal wavelength is near the fiber zero dispersion wavelength or in the anomalous dispersion region. Therefore, the dispersion at the high power region (the head of each fiber span) must have the normal dispersion value of less than -0.63ps/km/nm as shown in Figure 4. The dispersion value towards the end of the span must lie in the anomalous region to realize dispersion compensation. This dispersion management holds the total dispersion at the signal wavelength of 1552nm to less than ±70 ps/nm. The resultant eye opening penalty caused by SPM & GVD is less than 1dB at the 6dBm output power.

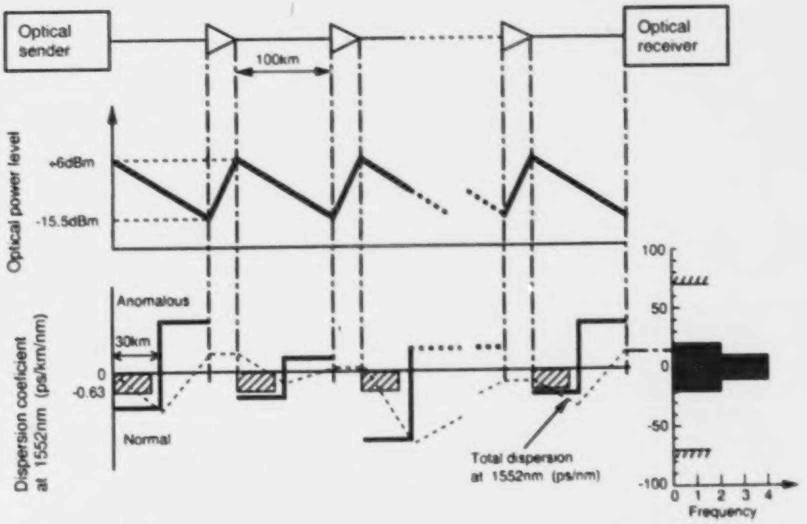


Figure 4. Dispersion management schmatic illustration and test results of total dispersion of the installed 12 fiber lines (905km)

3.3 MARINE and Supervisory Signal Transmission

3.3.1 MARINE Outline

In a submarine system, it takes a long time to repair repeaters or cable breaks because special ships must work on the sea surface. To operate FSA more easily, an operation system (MARINE) has been developed. MARINE consists of a commercial personal computer, software, and a public telephone line as shown in Fig.2. FSA-MARINE performs the in-service performance monitoring of repeaters. In addition to in-service performance monitoring, the operation system detects alarms in SV terminals and power feed equipment such as package failures and loss of signal. Electrical current and electrical voltages in the power feed equipment are also monitored.

3.3.2 SV Signal Transmission and In-service Monitoring

A unique in-service supervisory signal transmission scheme suitable for optical amplifier repeater systems with quite simple supervisory hardware was developed for FSA. The supervisory signal is transmitted by over-modulation of the line signal as shown in Fig.2. The submarine repeater can be monitored even if the line signal is shut off because the supervisory signal can be superimposed on the ASE noise. The over-modulation index and frequency are designed not to degrade or modify line signal transmission. This scheme monitors the input power, output power, and electrical current of the pump laser, and the ambient temperature. A change in any value may be used for forecasting failures.

3.3.3 Fault Location by C-OTDR

C-OTDR is an effective technique for finding faults along a fiber. However, OTDR cannot be used with transmission lines containing traditional repeaters. The FSA repeaters establish a by-pass optical circuit to return the back scattered light to the OTDR setup as shown in Fig.3. This permits fault location in the FSA transmission line containing repeaters.

4. INSTALLATION TEST RESULTS

4.1 Outline of the Route and Path Restoration

Figure 5 shows the FSA installation route. The route length is 905km with a repeater spacing of 90km. The Kagoshima, Kyushu- Okinawa route is a commercial trunk line. The FSA repeaters and cables were laid by a cable ship Kuroshiomaru(NTT-Marine) from March to April in 1995. FSA commenced commercial operation as a 2.4 Gbit/s transmission system; upgrading it to 10 Gbit/s would be possible without replacing the submerged optical transmission line, only the terminals need to be changed as shown in Fig.6.

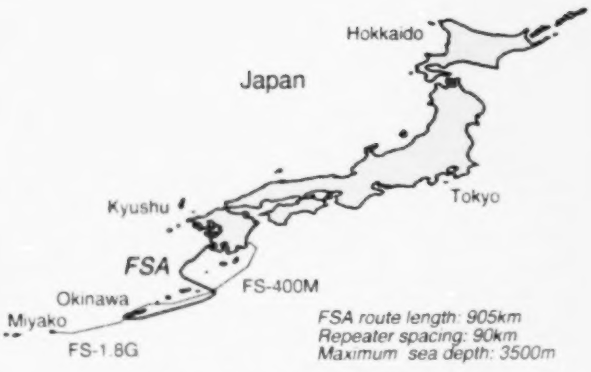

Hokkaido
Japan
Tokyo
Kyushu
FSA
FS-400M
Okinawa
Miyako
FS-1.8G
FSA route length: 905km
Repeater spacing: 90km
Maximum sea depth: 3500m

Figure 5. FSA installation route

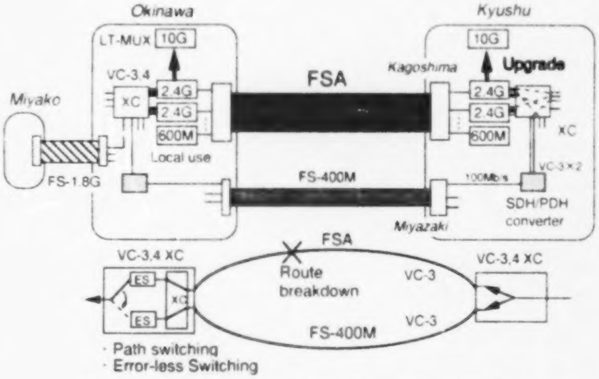

Okinawa
Kyushu
LT-MUX
10G
10G
Kagoshima
Upgrade
VC-3,4
FSA
XC
2.4G
2.4G
600M
Miyako
XC
Local use
FS-1.8G
FS-400M
100Mb/s
VC-3×2
SDH/PDH converter
Miyazaki
FSA
VC-3,4 XC
VC-3,4 XC
Route breakdown
VC-3
VC-3
ES
ES
XC
FS-400M
· Path switching
· Error-less Switching

Figure 6. Network configuration and restoration with FSA and FS-400M

SDH signals are transported using the existing PDH transmission system(FS-400M) with an SDH/PDH converter as shown in Fig.6. This converter places two VC-3s into the existing digital 4-th stage(100Mbit/s) by means of the multi(4)-frame structure(13). Therefore, path restoration for route breakdown in either FSA or FS-400M is done by the VC-3,4 digital cross-connect system. It also supports errorless switching(2) using elastic stores to absorb the phase difference between the two transmission lines. This function is useful for terrestrial cable relocation or preventive repair of submarine systems.

4.2 Transmission Performance

4.2.1 Line Signal Transmission Test Results

For all 120 optical amplifiers in the 10 FSA submarine repeaters, optical output power and noise figure were measured as shown in Fig.7. Optical output powers were within 5.5 and 6.5 dBm for the undersea temperatures of 0, 15, and 30°C. Excellent noise figure performance of about 6dB was also achieved. The typical optical amplified bandwidth performance is shown in Fig.8 with the specification of the mask.

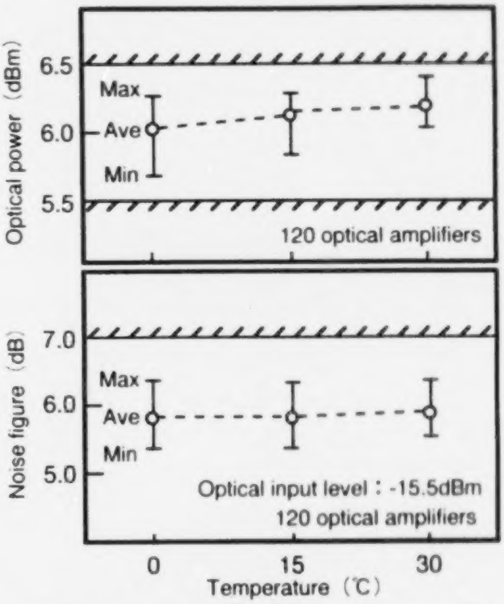


Figure 7. FSA submarine repeater optical output power and noise figure

For the 6 systems, transmission performances at 2.5Gbit/s and 10Gbit/s were examined after installation. The SNR performance at the shore terminal receiver was evaluated from the behavior of the BER as a function of the decision threshold setting in the region where the BER is measurable(14). The SNR in this paper is defined as $SNR(dB)=10\log(4Q^2)$ where Q-value is described in ref.(14). Each system was confirmed to offer stable SNR over 29 dB at 10Gbit/s(average). No degradation occurred through the laying operation by comparing the performance before and after laying.

Typical time fluctuation of SNR is shown in Fig.9. Generally speaking, SNR fluctuates with PMD and PDL. The PMD and PDL values of the FSA commercial line(905km) were 2.2ps and 0.5dB respectively. Therefore, the fluctuation was small as shown in Fig.9.

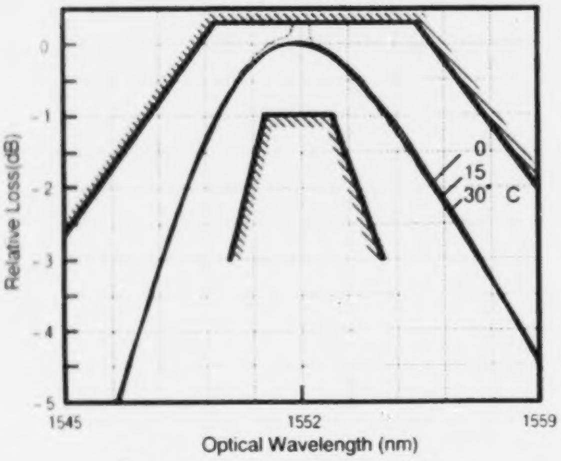


Figure 8. Optical amplified bandwidth

We estimate 2.1dB optical SNR degradation at each repeater section is caused by the optical output power decrease of 0.5dB, cable loss increase of 0.006dB/km and 1dB cable repair within the system life of 25 years. Approximate 2.1dB penalty in electrical SNR results from this optical degradation. Moreover, the electrical degradation caused by imposing the SV signal on the line signal must be considered as inter-symbol interference degradation. The designed SNR at the end of FSA system life(25 years) is 25dB which corresponds to the BER of 10^{-20}. This was calculated from the estimated SNR penalties as shown in Fig.9.

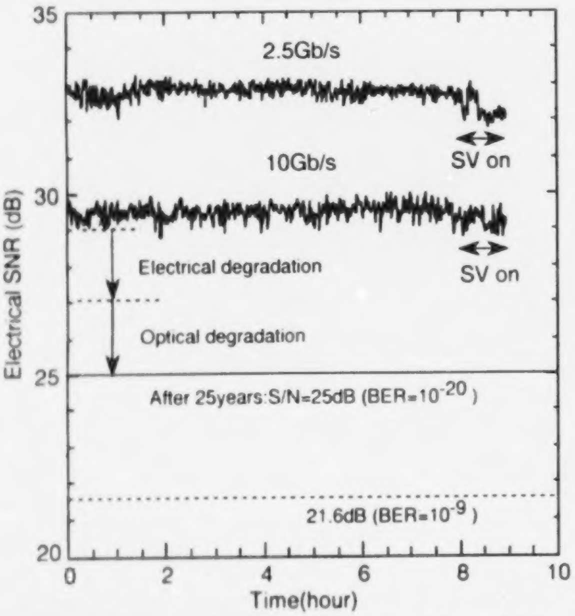


Figure 9. Electrical SNR fluctuation for 2.5G and 10Gb/s transmission

The total dispersion of the 12 installed fiber lines was ±20ps/nm as shown in Fig.4. Therefore, the waveform distortion by SPM and GVD is quite small.

4.2.2 Supervisory Test Results

Repeater operating performances were checked by confirming input power level, output power level, electrical current of the pump laser, and ambient temperature. There was no degradation through the laying operation by comparing the performance before and after laying. The only change was the ambient temperature; from room temperature to almost 0°C. The ambient temperature must be known to calibrate the temperature fluctuation of the voltage-control-oscillator in the monolithic SV-IC. MARINE allows the input power level, as an example, to be monitored with an accuracy of ±2dB at -15dBm input power. This is accurate enough for maintenance purposes. SNR degradation caused by the 5% modulation index of the supervisory signal was less than 1dB as shown in Fig.9. This degradation meets the SV specification for in-service monitoring.

Fault location with 1km accuracy was done for all repeater sections from land by C-OTDR with 10 μs width probe optical pulse. The SNR degradation caused by returning the back scattered light from the counter line through the backscatter path was measured. It was less than 0.5dB which was within measurement error(15). This indicated that using the backscatter path with an optical loss of 18dB is reasonable with FSA submarine repeaters.

5. UPGRADE TRIALS AND DISCUSSION

5.1 Upgradability Test Results

FSA system capacity was tested using WDM and optical soliton transmission techniques(16)(17). The test results are shown in Fig.10.

First, the long distance transmission performance of FSA is described. By inter-connecting all 6 systems, 10,000km transmission was demonstrated. 2.5Gbit/s-9,720km, 10Gbit/s-6,480km transmission was successfully carried out as shown in Fig.10. The SNR was 27.7dB at 2.5Gbit/s-9,720km and 22.1dB at 10Gbit/s-6,480km with polarization scrambling at 10GHz and 1MHz, respectively(18). To achieve this transoceanic distance transmission, the optical wavelength was adjusted within 0.1nm of the zero dispersion wavelength to avoid waveform distortion due to second order dispersion. There was no excess noise increment when adjusting the wavelength because of the dispersion management. A 1nm optical filter was also used at the receiver to cut the accumulated ASE noise.

WDM transmission in the FSA is limited by (1)the channel power reduction enforced by ALC, (2)total optical amplified bandwidth in the chain of EDFAs with optical filters and (3)dispersion degradation of the edge channels far from the center wavelength 1552nm($B^2 \cdot L$). The 2 wavelength signals transmitted at 10Gbit/s over 2715km approach the noise limitation($B \cdot L$), since each signal power was decreased by 3dB by ALC as shown in Fig.10. When increasing the number of channels, limitation factors (2) and (3) are dominant. The pre-emphasis technique at the optical senders was used to achieve 5 wavelength signal transmission(5×10Gbit/s-905km), since the optical bandwidth of the 9 repeater chain (905km) was 5nm. Although the wavelengths were allocated with 1nm channel separation, the effect of fiber four wave mixing(FWM) was negligible. This indicates that the dispersion management in the FSA works well with 1.5 μm zero dispersion fiber transmission.

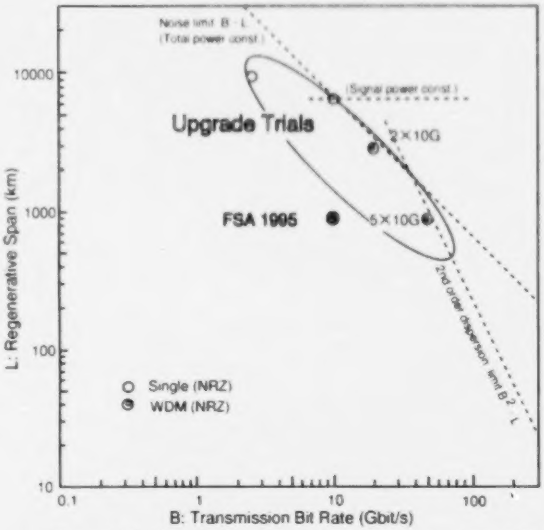


Figure 10. Upgrade trial results in the commercially installed FSA system

To confirm the bit-rate transparency of FSA, an NRZ signal was tested at 20Gbit/s. The result shows 1,810km transmission was possible; the SNR was 22.6dB.

For evaluating the dispersion management effect on optical soliton transmission, optical solitons with 20ps pulse width were examined. The FSA system configuration is optimized for IM-DD NRZ transmission so there are two main items against optical soliton transmission: fixed 6 dBm optical power with ALC and fiber dispersion management. To get optical solitons with 1dBm output power at the average dispersion of 0.2ps/km/nm, the optical wavelength was set to around

1555nm with one dummy CW light. This achieved 2,715km optical soliton transmission without pulse spreading.

To summarize the upgrade trials, we demonstrated the excellent performance, close to the noise limitation (B·L) and 2nd order dispersion(B^2·L), of the FSA system as shown in Fig.10. FSA offers long distance transmission, and transparency to bit rate and modulation format.

5.2 Future Submarine Network Discussion

Based on the upgrade trials described above and other recent optical devices and technologies, a promising future optical submarine network is shown in Fig.11. In this submarine network, it is important to achieve high reliability and flexibility. On the reliability side, the submarine network basically takes the ring configuration for failure restoration as shown in Fig.11. Partial power feed is also needed to avoid full network down by repair.

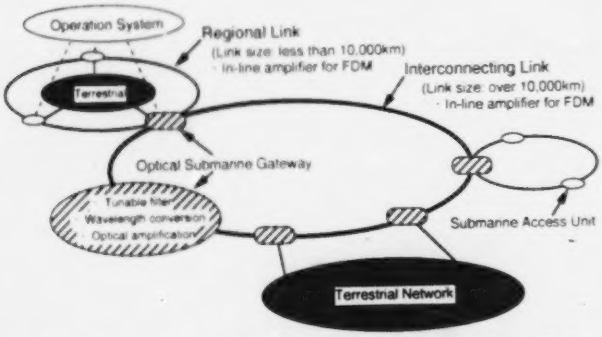


Figure 11. An example for the future WDM based optical subamarine network

As for network flexibility, it provides logical full-mesh connection, transparency to bit rate and modulation format, and ease of increasing or decreasing transmission capacity from end to end. To achieve this network flexibility, the WDM-based network(19) using in-line optical amplifiers is quite promising for regional links and interconnecting link. The function of the optical submarine gateways is wavelength selection to chose the necessary wavelength, wavelength conversion for the efficient use of wavelength resources or wavelength routing and optical amplification of multi-wavelength signals.

It is quite important to consider network size from the viewpoint of propagation delay and transmission capability with in-line optical amplifiers. If the total length is 30,000km, the round trip time due to the finite speed of light in fiber is about 290ms. This latency is not **negligible in comparison with computer processing speed** on data communications(20). Therefore, it is important to decrease the time delay by processing in the submarine access units and optical submarine gateways. Direct optical processing studies are necessary for decreasing this latency.

To accomplish ultra long distance transmission, it is necessary to study the FWM effect and inter channel crosstalk that mainly limit WDM network performance in addition to accumulated ASE noise, fiber nonlinear effect, PMD, and PDL.

6. CONCLUSION

The three main targets of FSA, bit rate flexibility, multi-system accommodation and improved operation, were achieved through the development of several technologies such as optical filtering, dispersion management, ALC, and in-service performance monitoring. Design concepts for line signal and supervisory signal transmission for long distance in-line optical amplifier submarine systems were described in detail. FSA bit rate flexibility was achieved for 600 M, 2.4 G and 10 Gbit/s with 100km repeater spacing.

The commercially installed FSA system showed stable SNR performance over 29dB with 10Gbit/s transmission. Stable optical output power, noise figure and optical pass band of FSA submarine repeater against ambient temperature changes were shown. Dispersion management well suppressed the excess noise and the total dispersion was within ±20 ps/nm so that SPM and GVD waveform degradation was suppressed.

Upgrade trials using WDM and optical soliton confirmed that the FSA system offers excellent long distance performance, transparency to bit rate and modulation format.

Finally, a WDM based submarine network using in-line optical amplifiers was proposed based on the upgrade trial results and recent optical devices. The major technological issues to be solved and functions to be realized were described.

REFERENCE

(1)K. Hagimoto, S. Nishi and K. Nakagawa, "An optical bit-rate flexible transmission system with 5-Tbit/s km capacity employing multiple in-line erbium-doped fiber amplifiers ", IEEE JLT, 8, No. 9, pp1387-1395, 1990.
(2)H. Miura, "The fundamentals of link system construction", NTT Review, Vol. 6, No. 6, pp16-23, 1994.
(3)M. Aiki, S. Saito and T. Ito, "Evolution of Optical Amplifier Submarine Systems", GLOBECOM'92, pp1431-1435, Orland, 1992.

(4)R.L.Mortenson, B.S.Jackson, S.Shapiro and W.F.Sirocky, "Undersea optically amplified repeatered technology,products, and challenges", AT&T Technical Journal, Vol.74, No.1, pp33-46, 1995.

(5)P.M.Gabla, "Optical amplification: the seed for expansion of submarine cable networks", PTC'95, pp74-80, Honolulu,1995.

(6)H.Iizuka, S.Kano and M. Yoshida, "Network technology supporting VI&P", NT&T Technical Journal, Vol.3, No.1, pp14-18, Jan. 1991.

(7)H.Ishio, T.Ito and M.Aiki, "Evolution of very high speed, long span submarine optical fiber transmission systems", NT&T R&D, Vol.43, No.11, pp1175-1180, 1994.

(8)K. Nakagawa,K. Hagimoto,S. Nishi and K.Aoyama, "A bit-rate flexible transmission field trial over 300-km installed cables employing optical fiber amplifiers", OAA'91, PD-12, Jul. 1991.

(9)M.Sumida, T. Imai and S.Furukawa, "Fault location on optical amplifier submarine systems", IMTC'94, pp110-113, Hamamatsu, 1994.

(10)T.Imai, M.Murakami and A.Naka, "Optimum parameter guidelines for 10Gbit/s,multi-megametre transmission systems considering the nonlinear effect", Elec.letters ,Vol.29, No.16, pp.1409-1410, Aug. 1993.

(11)D.Marcuse, "Single-channel operation in very nonlinear fibers with optical repeaters at zero dispersion", J. Lightwave Technol., LT-9, pp.356-361, 1991.

(12)T.Imai, M.Murakami and T. Takahashi, "Effects of fiber nonlinearity and polarization mode dispersion on long-distance transmission systems with optical in-line amplifiers", OFM'94, Boulder, 1994.

(13)H.Ueda, "A method for transporting SDH signals using existing transmission systems", IEICE,B-I,Vol.J-73, No.10, pp760-767, Oct. 1990.

(14)N.S.Bergano, F.W.Kerfoot and C.R.Davidson, "Margin measurements on optical amplifier systems", IEEE Photonics Technol. Lett., Vol.5, No.3, pp.304-306, Mar. 1993.

(15)M.Sumida, S.Furukawa, K.Tanaka and M.Amemiya, "Fault location on optical amplifier submarine transmission systems", IEICE,B-I, to be published.

(16)Y.Hayashi, Y.Fukada, H.Maeda, T.Takahashi and M.Aiki, "Verification of four-wave mixing suppression in WDM transmission experiments on the FSA commercial system with dispersion managed optical fiber cable", OFC'96, to be published.

(17)K.Iwatsuki, S,Saito, K.Suzuki, A.Naka, S.Kawai, T.Matsuda and S.Nishi, "Field demonstration of 10Gb/s-2700km soliton transmission through commercial submarine optical amplifier system with distributed fiber dispersion and 90km amplifier spacing", ECOC 95, Post-deadline papers, pp.987-990, 1995.

(18)M.Murakami, T. Takahashi, M. Aoyama, M.Amemiya, M.Sumida, N.Ohkawa, Y.Fukada,T.Imai and M. Aiki "2.5Gbit/s-9720km,10Gbit/s-6480km transmission in the FSA commercial system with 90km spaced optical amplifier repeaters and dispersion-managed cables", Elec.letters ,Vol.31, No.10, pp.814-816, May. 1995.

(19)H.Toba, K.Oda and K.Inoue "Wavelength division multiplexed networks", OAA'95 , pp.204-207, 1995.

(20)L. Kleinrock "The latency/bandwidth tradeoff in gigabit networks", IEEE Comm.. Magazine, 30, No.4 , pp.36-40, 1992.

FIBEROPTIC LINK AROUND THE GLOBE (FLAG)
The FLAG Cable System Network

By Robert E. Sullivan
Regional Program Manager - NYNEX Global Systems
White Plains, New York USA

Introduction

The FLAG Cable System will soon be the world's largest fiberoptic cable system, spanning over 27,000 kilometers. It will contain over 300 optically amplified repeaters and four (4) fiber switched branching units. The system is divided into two (2) separate 5 Gbit/s paths and will connect twelve countries between England and Japan. The terms Local and Express are used to distinguish between the two paths. The Local path will connect every country along the route. The Express will only land at all but three (3) of the countries. At the Express locations, the full 10 Gbit/s of capacity will be available. There are two locations where the FLAG Cable System will cross land. These routes, found in Egypt and Thailand, will be fully redundant and diversely routed. The FLAG Cable System will utilize Synchronous Digital Hierarchy (SDH) transmission architecture, based on ITU (formerly CCITT) transmission standards. The FLAG Cable System will differ from the more traditional cable systems in use today in that it is configured as a network using the capabilities of the SDH architecture and the terminal equipment. The terminal equipment descriptions follows a brief overview of the submerged portion.

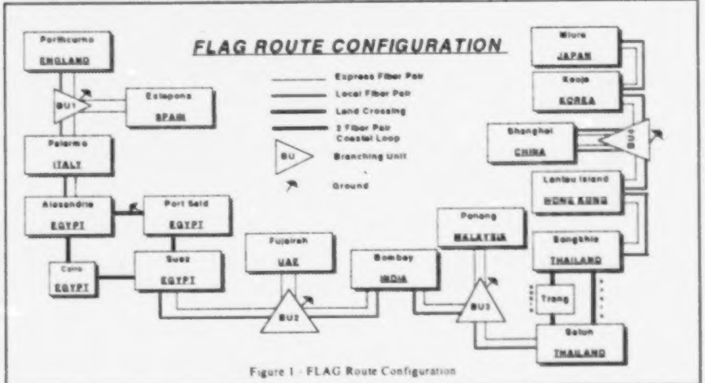

FLAG ROUTE CONFIGURATION
Express Fiber Pair
Local Fiber Pair
Land Crossing
2 Fiber Pair Coastal Loop
BU
Branching Unit
Ground
Porthcurno
ENGLAND
BU1
Estepona
SPAIN
Palermo
ITALY
Alexandria
EGYPT
Port Said
EGYPT
Cairo
EGYPT
Suez
EGYPT
Fujairah
UAE
BU2
Bombay
INDIA
Penang
MALAYSIA
BU3
Miura
JAPAN
Koje
KOREA
Shanghai
CHINA
BU4
Lantau Island
HONG KONG
Songkhla
THAILAND
Trang
Satun
THAILAND

Figure 1 - FLAG Route Configuration

Submarine Technologies

The FLAG Cable System will utilize Erbium Doped Fiber Amplifiers (EDFA), fiber switchable branching units and a redundant power feed configuration to provide the submerged part of the transmission path.

Erbium Doped Fiber Amplifiers (EDFA)[1]

The first generation of non-regenerative submerged repeaters will be used in the FLAG Cable System. These amplifiers do away with the process of optical to electrical to optical conversions used in many of today's cables. The amplifier directly increases the strength of the transmission signal along its path. The amplifier consist mainly of a pump laser operating at 1480 nm coupled into a wave division multiplexer (WDM) that is connected to the EDFA. This pump laser counter-propagates into the EDFA and stimulates the erbium. When a transmission signal of 1550 nm passes through the amplifier, the excited erbium ions release their energy to the transmission signal, thus boosting the transmission signal strength. The EDFAs also provide some self healing capabilities for the system. If an amplifier begins to decrease in strength, other amplifiers along that route will increase their gain to compensate for the loss. The diagram below provides the basic configuration and the major components.

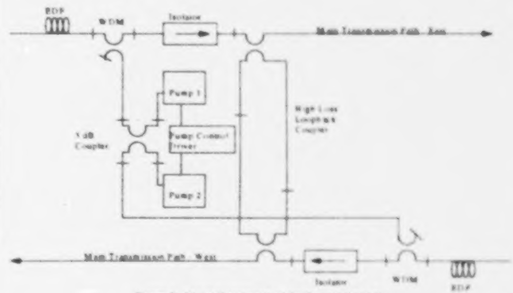

EDF
WDM
Isolator
Main Transmission Path - East
Pump 1
3 dB Coupler
Pump Control Driver
Pump 2
High Loss Loopback Coupler
Main Transmission Path - West
Isolator
WDM
EDF

Figure 2 Major Components of the Optical Amplifier

This amplifier design provides for the monitoring of the submerged plant. The high-loss loopback couplers act as a path for a supervisory signal. This signal is the result of amplitude modulation performed on the main transmission path. The is done at the cable station and is controlled by the Line Monitoring Equipment (LME).

The LME is a computer that interfaces with the 5 Gbit/s Submarine Line Terminating Equipment (SLTE), described later, to monitor the gain of the amplifier and record the history of the submerged plant. The LME will interpret the receive transmission signal and determine the gain of each repeater. This is accomplished by the high loss loop-back couplers in the repeater returning a portion of the transmission signal to the cable station. When the signal received at the cable station, another high loss coupler located in the 5 Gbit/s SLTE taps a portion of the signal for interrogation. The gain of each repeater can be determined by a time distance correlation. Since all of the amplifiers are connected in series, the closest amplifier's information will be returned first and then the second one's and so on. This provides FLAG the opportunity to monitor the health of the system or each amplifier individually. Thus, if there is a failure on the system or a degradation in one of the repeaters, FLAG can determine when or if a ship repair is required. Also, the supervisory path will allow FLAG to accurately locate a fault within a repeater section. FLAG will utilize Coherent Optical Time-Domain Reflectometer (COTDR) in the cable station that will utilize the high loss loopback path to provide a very accurate reading of the distance from the cable station to the cable break. This is an advantage over traditional, regenerative systems that do not allow for optical testing and must rely on less accurate electrical testing methods.

Fiber Switchable Branching Units

The FLAG Cable System will be implemented using fiber switchable branching units. At certain locations along the route, the cable will be brought to the landing site via a branching unit.

Theses units contain electrical relays that are controlled by the power state of the Power Feed Equipment (PFE) in the cable stations at either end of the segment. In normal conditions, the branching units provide a path for power to the main path and a ground to the branched cable station. If there is a fault on the cable in a segment that has a branching unit, the relays in the branching unit will change state based on the new powering conditions for the segment. These relays are connected to another set of relays that control optical switches within the branching unit. These optical switches will change the optical path for the segment based on the new power configuration. This will enable FLAG to restore around cable breaks, without loss of much of the traffic.

Power Feed Equipment (PFE) [2]

The PFE for the FLAG Cable System is designed as Doubled End Feed configuration, where possible. Double End Feeding is a configuration where cable stations at either end of a segment feed DC power to each other through the cable. Each PFE will provide half the power required for the segment, in a load sharing relationship. Each cable station's PFE is capable of powering the whole segment if the far end PFE fails. The remaining PFE will automatically increase its voltage to compensate for the loss of the far end cable station, with very little effect on the main transmission signal. This provides a great deal of redundancy and reliability to the FLAG Cable System. The cable landings of a branch are considered single end feeds and provide power to a ground at the branching unit. These cable station's PFEs will have an extra power converter that will provide redundancy for the branch locations.

Terminal Transmission Equipment

This next section will describe the transmission equipment used in the FLAG Cable System and will point out differences between the FLAG Cable System and many of the present cables in service today.

5 Gbit/s Submarine Line Terminating Equipment (SLTE)

The cable stations along the FLAG Cable System are connected by the 5 Gbit/s Submarine Line Terminating Equipment (SLTE) and each segment operates very much like a point to point at this level. The SLTE is the interface the transmission signal has to the submerged plant. This equipment takes two 2.5 Gbit/s, STM-16, SDH signals and bit interleaves them into a 5 Gbit/s signal. The SLTE adds the Forward Error Correction (FEC) to the transmission signal. This increases the actual transmission rate to 5.3 Gbit/s and provides a bigger margin in the optical power budget. And as stated before, the SLTE is also the interface used to monitor the submerged plant. It is connected to the 2.5 Gbit/s Add Drop Multiplexer(ADM) optically at the STM-16 level.

2.5 Gbit/s ADM

This is where the FLAG Cable System leaves the path of traditional cable systems. FLAG is plans on using these ADMs to provide four linear chains

264

through the system. The linear chains will have endpoints in England and Japan. The ADMs allow for any STM-1, 155 Mbit/s signal in an STM-16 signal to be dropped to any of their 16 ports. (An STM-1 can also be simply passed through the ADM to the next cable station.) This allows FLAG to groom the STM-1s signals efficiently. In order to take advantage of the efficiency gained at the STM-1 level, you have to groom at the E-1, 2.048 Mbit/s, level. This is accomplished by a Digital Cross-Connect System (DCS).

Digital Cross-Connect System (DCS)

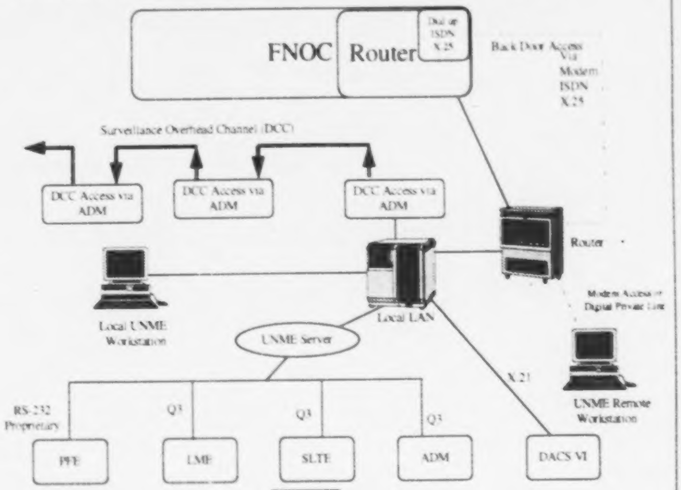
The DCS for FLAG will be the interface point for connection to the Landing Parties network to the FLAG Cable System. The DCS will interface with the Landing Parties at the STM-1 level. The E-1s contained within the Landing Party input STM-1 will pulled off and groomed by the DCS and placed into the output STM-1 for FLAG. This provides for a efficient network and will allow FLAG to plan the growth of its system.

The ADM and the DCS will also be the equipment responsible for the restoration of the FLAG Cable System. By utilizing the SDH architecture and the capabilities of the DCS and ADM to switch transmission paths, FLAG will utilize pre-planned restoration for different failure scenarios. This restoration scenarios will utilize in system (within the FLAG Cable System) restoration paths to be used and will utilize the out-of-system paths (other cable systems, satellite) that are available and switch the traffic to their. The DCS which has SDH to PDH conversion ability which can be used to put FLAG's SDH traffic on to a PDH as well as a backhaul system. These capabilities are strengthened through the centralized management of the system.

FLAG Network Management

The FLAG Network Management is perhaps the defining difference between FLAG and other cable systems of today. From one location called the FLAG Network Operations Center (FNOC), the entire FLAG Cable System can be controlled down to the E-1 level. The FNOC will be based on a software management system designed by AT&T-SSI called ITM 2000. From a single terminal in the FNOC, a technician will be able to query any cable station for any information required. The FNOC will be able to establish transmission paths and will be the center point of control for restoration.

The FNOC will be connected to the FLAG Cable System by a private line in the transmission overhead of the FLAG system to one of the cable stations. There, a router will connect the FNOC to the rest of the system via the Data Communications Channel (DCC). A wide area network (WAN) will be used to connect all the cable stations together. The main communication path between the cable stations will be over the D4-D12 bytes of the DCC. This provides for a 576 Kbit/s channel. The FNOC will also have dial-up facilities, outside of the cable, that can be used in the case of a major failure on the cable system that isolates a section of the cable. These dial up capabilities will allow communication to every cable station in the event of a failure, thus insuring the monitor and control capabilities of the FNOC.


FNOC
Router
Dial up
ISDN
X.25
Back Door Access
Via
Modem
ISDN
X.25
Surveillance Overhead Channel (DCC)
DCC Access via ADM
DCC Access via ADM
DCC Access via ADM
Router
Modem Access or
Digital Private Line
Local UNME
Workstation
Local LAN
UNME Server
X.21
UNME Remote
Workstation
RS-232
Proprietary
Q3
Q3
Q3
PFE
LME
SLTE
ADM
DACS VI

FLAG Network Management in Local Cable Station

Figure 3

At each cable station, there will be a local area network (LAN) to handle the communications between the terminal equipment. The supervision of the cable station will be provided by the following elements; the Undersea Network Management Equipment (UNME) server, the UNME clients.

The UNME server will be a computer that will act as a host and will contain the application software used to manage the cable station. The UNME server is connected to the terminal equipment via Q3 interfaces except for the PFE and the DCS. The PFE will be connected via a proprietary RS 232 interface and the DCS will be connected via a X.21 interface. The control of the cable stations will actually be done from the client workstation. This workstation will have a graphical interface to all of the station's elements. From here, a technician will be able to monitor and control the entire cable station, communicate with the FNOC and other cable stations, print reports or do historical database searches. Figure 3 shows the basic layout of the cable station and how the elements are connected. The overall system of the FNOC and the local supervisory system provides FLAG with a total network management system.

Conclusion

The FLAG Cable System has been designed from the start to be a revolutionary cable system. FLAG has approached the idea of a traditional point to point cable system and made it into a network. This allows for a great deal of flexibility within the system. It also provides the environment needed to plan and grow a network on a global scale. By placing the system and selling capacity in a "as you need it" fashion, the FLAG Cable System brings together the latest technologies and the right marketing and sales techniques needed to serve its target audiences.

References

1. Mortenson, et. al., "Undersea Optically Amplified Repeater Technology," *AT&T Technical Journal*, January/February 1995, Vol.74, No.1,pp.34-36
2. Sirocky, et. al., ".," *AT&T Technical Journal*, January/February 1995, Vol.74, No.1,pp.

Future submarine networks: the benefit of new technologies

P.M. Gabla

Alcatel Submarine Networks
Nozay, France

Abstract

Owing to major new technologies, such as optical amplification, wavelength-division multiplexing and forward error correction, submarine systems have undergone major changes over the last decade. They are evolving from point-to-point links towards integrated networks, providing superior transmission quality, near-perfect availability of traffic channels and increased connectivity.

Introduction

During the last decade submarine systems have benefited from a technological quantum leap, with the replacement of electro-optical regenerative system designs by optical amplification-based system configurations.

Optical amplification has indeed been the focal technology of what can be called the "network revolution". Optical amplification, owing to its transparency to signal format, has enabled the development of flexible system design solutions.

In addition to the potential for very high capacities, optical amplification allows wavelength-division multiplexing to enhance routing and networking flexibility. It is therefore a gateway to the transparent optical transport medium, embodied by the cable web that is being deployed around the world.

Optical amplification also enhances the advantage provided by error correcting codes, leading to high performance transmission systems.

In this paper, the technical and functional benefits derived from these new technologies are presented and examples of implementation, for both repeatered and unrepeatered systems, are described.

Enabling technologies

Optical amplification

Although physical principles had been known since the early 1960s, optical amplification really gained momentum at the beginning of the 1990s, when practical devices were realised, based on erbium-doped fibre and semiconductor laser pump sources.

Since the beginning of the 1990s erbium-doped fibre amplifiers (EDFAs) have been used in virtually every type of fibre optic communication system, whether it be digital or analogue, terrestrial or submarine.

The erbium-doped fibre amplifier is indeed very simple to implement, as the amplifying medium is a piece of optical fibre doped with erbium ions, and the pump source is a semiconductor laser diode, usually emitting at 1480 nm.

Additionally, the EDFA features excellent transmission characteristics, such as high gain, low noise, high output power, high linearity, low polarisation sensitivity, which makes it a basic building block for modern fibre optic communication systems.

One of the foremost limitations of fibre optic transmission systems is signal attenuation in the line fibre. Optical amplifiers, which directly amplify the weakened optical signal whenever necessary along the fibre path, greatly simplify the design of fibre optic transmission systems, as they alleviate the need for opto-electrical signal processing, as was the rule with regenerative repeaters.

Regenerative repeaters are also called "3R" repeaters, as they perform three operations: Re-time, Re-shape and Re-amplify the weakened and distorted signal. These operations are performed in the electrical domain, hence optical-to-electrical (at the input, with a photo-detector) and electrical-to-optical (at the output, with a laser) conversions are necessary within each repeater. These operations not only break the continuity of the optical path, but make the repeater capacity-dependent. To build a higher bit rate system, the 3R repeater must be totally re-designed.

Optical amplification is intrinsically bit rate independent, even capacity-independent as an optical amplifier can simultaneously amplify several channels at different wavelengths. Hence optically amplified systems can —if thoughtfully designed— be upgraded to higher capacities by just changing terminal equipment, either by using higher bit rate equipment or by adding channels at different wavelengths.

267

Wavelength-division multiplexing (WDM)

The possibility of WDM transmission in amplified systems is a direct consequence of optical amplifier transparency to signal capacity.
The intrinsic optical bandwidth of optical fibre lines is extremely large: in the 1.55 μm window, the available bandwidth ranges from 1500 to 1600 nm. This 100 nm wavelength domain converts into a 12.5 THz frequency domain. With a 10 Gbit/s transmission rate for example, only a fraction of this domain is used.
Erbium-doped fibre amplifiers operate in the 1530 to 1565 nm wavelength range, which corresponds to a frequency domain of 4.5 THz. Wavelength-division multiplexing is a way to exploit this wide bandwidth, by sending many channels at wavelengths spanning the available window.
An obvious advantage of WDM is that very high aggregate capacities —several tens of Gbit/s— can be reached with reasonable electronics complexity, as each unitary channel operates at 2.5 or 10 Gbit/s.

But the most prominent advantage of wavelength-division multiplexing is the enhanced networking capability that is enabled by wavelength routing and branching. By using wavelength-selective components in network nodes or branching units, a higher degree of network flexibility is obtained. Key components are therefore transmitters and receivers able to operate in a range of wavelengths, and optical filters that can perform static or dynamic channel selection.

Forward Error Correction (FEC)

Another trademark technology of modern submarine systems is forward error correction. It consists in mathematical processing of the logical bit sequence ("zeros" and "ones" of the digital signal) implemented in the transmitter and receiver. The performance of FEC algorithms is such that as soon as the bit error ratio (BER) before correction is below 10^{-4}, the system operates virtually error-free (BER $<< 10^{-14}$).
The price to pay is an increase in the transmitted bit rate —typically 7%— to accommodate the redundancy required by the encoding and decoding algorithms.

In unrepeatered systems, the advantage translates into improved receiver sensitivity, as the optical power necessary to obtain a 10^{-10} BER (standard requirement) after correction corresponds to the power necessary for a 3×10^{-4} BER before correction.
In repeatered systems, the target BER is below 10^{-15} after correction, so that the target BER before correction is about 10^{-4}. Therefore the advantage of error correction is an additional system margin. This margin can be preserved as such, or spent to decrease the system signal-to-noise ratio requirement, hence increasing repeater spacing, for example.

A discriminating feature of forward error correction is that, as it operates on the logical signal, its performance improvement is always available, whatever the origin of physical limitations of the fibre optic transmission system.
Additionally, the coding/correcting algorithm provides the number of corrected errors. Hence it is possible to monitor the system transmission performance (and its evolution with time), even though there are no errors on the traffic signal (owing to error correction). The evolution of system performance can then be monitored even when operating error-free, and any degradation of the BER after correction can be predicted before it actually occurs.

Unrepeatered systems

Post-amplifiers and pre-amplifiers

Owing to their great simplicity, optical amplifiers have found immediate applications in unrepeatered systems. Straightforward applications are post-amplifiers and pre-amplifiers.
Post-amplification is an almost transparent use of an optical amplifier, as the amplifier noise penalty is negligible, owing to high post-amplifier input power. The amplifier is deeply saturated, but this does not cause any distortion, owing to the great linearity of erbium-doped fibre amplifiers. EDFAs enable very high launched powers and fibre non-linearities, such as stimulated Brillouin scattering (SBS), stimulated Raman scattering (SRS) and Kerr effect, become the major limitation with post-amplifiers. However, provided adequate counter-measures are taken, more than +18 dBm (100 mW) can be launched at 2.5 Gbit/s with post-amplifiers, instead of typically 0 dBm (1 mW) with a conventional transmitter laser.
An optical pre-amplifier, which provides optical gain prior to photo-detection changes the balance of receiver noise terms. When receiver thermal noise becomes negligible compared to amplifier-generated noise, the pre-amplified receiver reaches a greatly improved sensitivity.
A good pre-amplifier features high gain, low noise and narrow optical filtering to block amplifier noise around the signal. If these conditions are met —which is not difficult to achieve in practice— the sensitivity obtained is very close to theoretical limits, and indeed very close to that of coherent heterodyne receivers.

Remotely pumped amplifiers

Considering that it is useless to increase the pre-amplifier gain beyond the point where receiver thermal noise is negligible, the idea behind remotely pumped amplifiers consists in converting excess gain into increased transmission span, this additional span loss being located between the amplifier and the terminal station. As long as the aggregate gain between the remote pre-amplifier input and the photodiode is sufficient to overcome receiver noise, the pre-amplifier-type considerations are still valid.

To maintain the "unrepeatered" quality of the system, which means "no electrically active element underwater", the pumping source is placed in the terminal station.

Pump power available in the terminal station is of paramount importance, because for higher pump powers, the amplifying erbium-doped fibre (EDF) can be placed further away from the terminal station while still featuring sufficiently high gain and low noise.

Remotely pumped amplification can also be used at the transmit side, although the rationale is different. The main limiting factor is fibre non-linearity, which places an upper limit on the launched power. By locating the amplifier away from the transmit terminal, and pumping it from the terminal, a span increase corresponding to the fibre section between the terminal and the remote post-amplifier can be obtained, provided that the signal power at the remote amplifier output does not exceed the maximum power determined by fibre non-linearity.

Demonstrations of advanced unrepeatered systems

To demonstrate the capabilities described above, various demonstrations have been realised in the laboratories. At the end of 1994, ultra-long unrepeatered spans of 511 km at 2.5 Gbit/s and 531 km at 622 Mbit/s, with use of post- and pre-amplifiers, remotely pumped post- and pre-amplifiers, forward error correction, pure silica core line fibre (PSCF) and dispersion-compensating fibre (DCF) were demonstrated [1]. The contributions of each system enhancement to the total power budget can be split as follows, at 2.5 Gbit/s: 15.5 dB from the (terminal) post-amplifier, 9 dB from the remote post-amplifier (50 km away from the transmit terminal), 7 dB for the (terminal) pre-amplifier, 17.5 dB for the remote pre-amplifier (100 km away from the receive terminal) and 5.5 dB for forward error correction. The total improvement is 54.5 dB, which leads to a 88.5 dB power budget at 2.5 Gbit/s, a drastic improvement compared to systems without optical amplification.

During 1995, the RIOJA system was installed, between Spain, the UK, Belgium and the Netherlands. The link between Belgium and the Netherlands is the first commercial use of a remotely pumped pre-amplifier and proves the viability of this technology in a "real-life" environment [2].

Expanding on the experiment reported in [1], a further demonstration was achieved recently where, by using wavelength-division multiplexing, 16 channels were transmitted at 2.5 Gbit/s (with FEC) over a 427 km unrepeatered span [3]. The set-up, depicted in Figure 1, was broadly similar to the set-up of the previous experiment, except for a shorter middle fibre section. This result shows that, in addition to providing very long span capability, optical amplifiers can also enable significant increases in the capacity of unrepeatered systems.

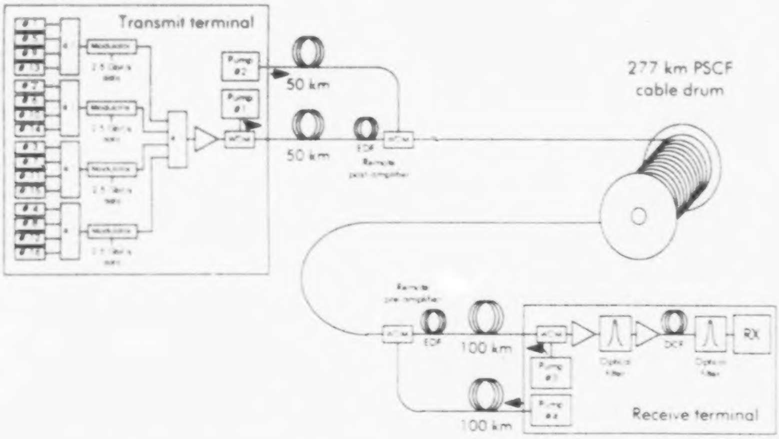


Figure 1 . 427 km, 16 x 2.5 Gbit/s unrepeatered demonstration

Repeatered systems

Optical amplification has introduced radical changes to the design methodology for submarine repeatered systems. The generation before optical amplifiers was based on regenerative "3R" repeaters (see above), where the system design was essentially a single span design. Indeed a complete link looked more like the concatenation of elementary "optical transmitter - fibre - optical receiver" blocks. In 3R repeaters, signal distortions were cancelled and signal-to-noise ratio was restored to a near-perfect quality. The system was thus designed for optimum single span performance at a given bit rate, and the repeater spacing did not depend on the total distance.

On the other hand, in optically amplified (1R) systems, the repeater is "universal" (i.e. suitable for any bit rate, in principle) as the signal is handled in its optical form, but distortions build up and signal-to-noise ratio decreases over the whole system length. Thus the system design (including repeater spacing) must be targeted for the total system length.

Specific line design issues arise from the non-regenerative nature of optically amplified systems. Major system limitations arise from amplifier noise build-up, fibre chromatic dispersion, fibre non-linearity and polarisation effects.

Conflicting constraints, such as high repeater input power to maintain a good signal-to-noise ratio, and moderate repeater output power to contain non-linear effects, lead to variable repeater spacing, according to system length and bit rate.

In addition to its universality, the optically amplified repeater is inherently much simpler than a regenerative repeater, as it does not include high speed electronics. Its reliability is therefore significantly better than for previous generations.

A large number of repeatered systems using optical amplifier are now being installed worldwide, the most notable examples being TAT-12/TAT-13 (transatlantic ring network), TPC-5 (transpacific ring network) and APCN (south-east Asia mesh network). These systems feature two fibre pairs operating at 5 Gbit/s, for a total capacity of 10 Gbit/s.

WDM repeatered systems

As mentioned above, wavelength-division multiplexing enables a large increase in capacity, with reasonable technological difficulty, as each of the unitary channels features a moderate bit rate, usually 2.5 Gbit/s. However, specific system design issues arise in WDM repeatered systems.

As the repeater output power is split between several channels, a higher total repeater output power is required to preserve a good signal-to-noise ratio for each channel.

Fibre non-linearities, already a problem in single channel systems, create additional difficulty as they enhance interactions between the channels. To reduce the impact of non-linearities, channels must not be too close to one another and the chromatic dispersion of the line must be managed in a specific way: a possible scheme is to operate with a large chromatic dispersion in line, and to compensate periodically with fibre of opposite dispersion.

The channel spacing issue emphasises the problem brought by non-flat repeater gain spectrum: gain non-flatness reduces the available wavelength window, and conflicts with the requirement to put channels far from one another to limit channel non-linear interactions.

Finally, a number of interaction effects depend on the relative polarisation state of the signal channels. It is therefore quite important to control the relative polarisation states or to scramble the polarisation at the transmit terminal to average these interactions and avoid excessive signal-to-noise ratio fluctuations due to the random nature of polarisation effects.

Wavelength add/drop branching unit

The key device for WDM networking is the wavelength add/drop branching unit (W-ADM BU). The basic function of this device is described in Figure 2. The W-ADM branching unit allows the extraction of an optical channel from a multiplex of optical channels, and also allows insertion of an optical channel into the main trunk path carrying the optical multiplex.

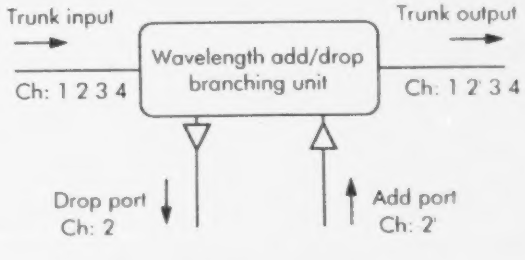


Figure 2 . W-ADM branching unit

In the example drawn in Figure 2, the inserted channel has the same wavelength as the extracted channel (this feature is called "immediate wavelength re-use"), but this need not be the case. Actually, several channels can be added/dropped, if required.

The first generation of W-ADM branching units will provide fixed optical channel selection but, in the mid-term future, W-ADM branching units will probably offer re-configurable channel routing, considerably increasing network flexibility.

5 Gbit/s 15,200 km and 2 x 5 Gbit/s, 7600 km TAT-12 field trials

To demonstrate the feasibility of these WDM concepts, system tests were carried out on a portion of the TAT-12 system, during the installation phase.

On a 3800 km section between the USA and the UK supplied by Alcatel (3800 km length), the four fibres included in the cable were looped back on the cableship (see Figure 3), allowing 7600 km and 15,200 km tests to be carried out from the Land's End (UK) station [4].

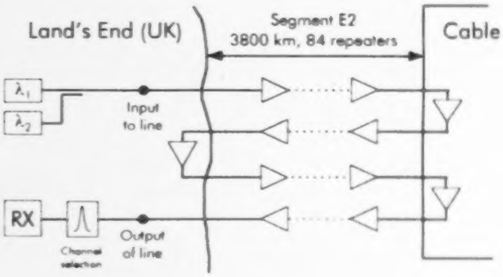

Land's End (UK)
Segment E2
3800 km, 84 repeaters
Cable ship
λ1
λ2
Input to line
RX
Channel selection
Output of line

Figure 3 . TAT-12/E field trial

The system measurements showed that this type of system configuration, with 45 km repeater spacing and +3 dBm repeater output power allows satisfactory transmission at 5 Gbit/s over 15,200 km and at 2 x 5 Gbit/s over 7600 km, with reasonable margin if forward error correction is employed.

Of course, a 15,200 km length does not relate to any foreseeable system, but these tests demonstrate the potential of optically amplified system technology.

4 x 2.5 Gbit/s, 3711 km field trial on the installed RIOJA system

To evaluate the potential of WDM systems further, we have conducted transmission experiments on two installed segments of the RIOJA system (see Figure 4), the first repeatered system in Europe using optically amplified technology [5].

The RIOJA system is designed for operation at 2.5 Gbit/s, with an upgrade capability to 5 Gbit/s, and tests have been carried out at 4 x 2.5 Gbit/s (10 Gbit/s total capacity) to demonstrate the efficiency of the WDM approach in repeatered systems.

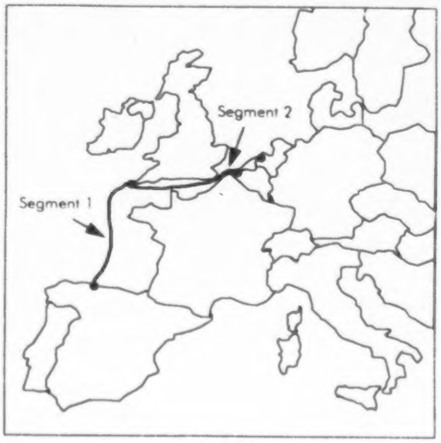

Segment 2
Segment 1

Figure 4 . The RIOJA cable system

Figure 5 shows the configuration of the 4-channel WDM system test. The total transmission distance of 3711 km was obtained by connecting together the four fibres contained in the cable at each end of the link between Spain and the UK. The transmitters at four different wavelengths were multiplexed into a single fibre line, and at the receive side, an optical filter was used to select the desired channel.

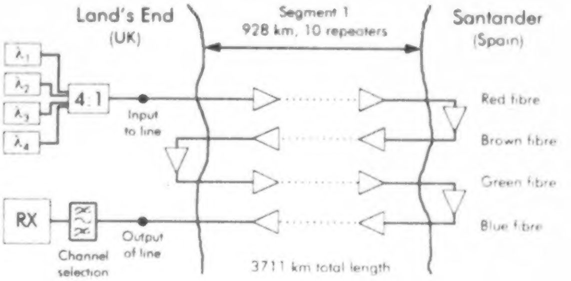

Land's End
(UK)
Segment 1
928 km, 10 repeaters
Santander
(Spain)
λ1
λ2
λ3
λ4
4:1
Input to line
Red fibre
Brown fibre
Green fibre
Blue fibre
RX
Channel selection
Output of line
3711 km total length

Figure 5 . 4 x 2.5 Gbit/s WDM field trial

Because of the non-flat optical amplifier gain spectrum, signal pre-emphasis —increasing the power of channels on the sides compared to channels close to the system gain peak— is applied at the transmit side, in order to obtain a uniform signal-to-noise ratio over all channels at the end of the system.

An additional feature tested in this field trial —for the first time ever— was the functionality of a wavelength add/drop branching unit (W-ADM BU). A prototype W-ADM branching unit was inserted between the link between Spain and the UK (installed) and the link between the UK and Belgium (during lay) at the Land's End cable station. At mid-way (after 1860 km transmission), one of the four channels (channel n° 2) was dropped and another signal at the same wavelength was inserted. The dropped and inserted signals both exhibited satisfactory error-free transmission performance.

Soliton repeatered systems

Considering that conventional optically amplified systems (using the non return-to-zero —NRZ— modulation format) are limited to 5 or 10 Gbit/s per channel for transoceanic systems, soliton transmission is a powerful way of coping with one important limitation of non-regenerated optical transmission systems: the interaction of fibre non-linearity and chromatic dispersion. Soliton transmission essentially results from a different signal modulation format, combined with specific propagation conditions.

A soliton pulse is a particular solution of the propagation equation in optical fibre. It has the property of propagating without distortion, as long as an adequate relationship is preserved between the pulse power, the pulse width and repetition rate, and the fibre chromatic dispersion.

The design of soliton transmission systems obeys particular rules and copes with specific limitations. Major limiting physical phenomena include signal-to-noise ratio degradation, soliton timing jitter (induced by amplifier noise and by interactions between adjacent soliton pulses) and polarisation effects.

To maintain the soliton propagation conditions, a number of requirements must be met simultaneously. If we take the example of varying the bit rate, a higher bit rate requires a narrower pulse width (about 1/5 of the bit rate, to limit pulse interaction) and smaller absolute jitter, which implies smaller chromatic dispersion. But a higher bit rate also requires a higher repeater output power to preserve sufficient signal-to-noise ratio, which implies higher chromatic dispersion. These conflicting requirements define the system design space, i.e. the range of acceptable operating conditions. If there is no suitable operating design space with large repeater spacing, soliton in-line control methods are necessary. It is highly likely that it will be the case because without control, soliton systems are limited to about 5 Gbit/s over transoceanic distances, which means that conventional (i.e. NRZ) systems offer better performance for these configurations.

Soliton control introduces non-linear loss in the system. This helps the soliton pulses to retain their shape and frequency, but is detrimental to amplifier noise. This noise reduction improves the signal-to-noise ratio and reduces noise-induced jitter (Gordon-Haus jitter). A number of options are available for soliton in-line control: fixed filters, fixed sliding filters, or synchronous modulation (see below), all of these methods being applied for example in each repeater.

Soliton transmission has the potential for very high capacity transmission, from 20 to 160 Gbit/s total capacity, with a combination of high channel rate and WDM. Additionally, much larger repeater spacings than with NRZ systems are expected owing to soliton control techniques.

10 Gbit/s, 13,000 km and 20 Gbit/s, 20,000 km soliton transmission demonstrations

Experiments have been carried out at 10 Gbit/s and 20 Gbit/s, in a re-circulating loop configuration, to demonstrate the potential of soliton transmission.

In the re-circulating loop set-up, a finite length pulse train is injected into a fibre loop, circulated a number of times around the loop, and then extracted out of the loop to be demodulated by a gated receiver.

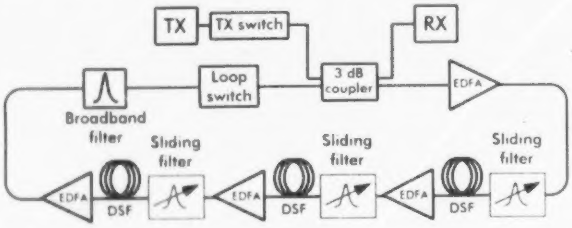


Figure 6 . 10 Gbit/s soliton re-circulating loop

In the 10 Gbit/s experiment [6], the loop comprised 4 optical amplifiers separated by three 63 km dispersion shifted fibre (DSF) spans, and soliton control was implemented with sliding filters, i.e. filters whose central wavelength "slides" from one filter to the next along the whole system length, at a determined shift rate related to the system bit rate and amplifier spacing. Error-free transmission over 13,000 km was demonstrated on this system.

In the 20 Gbit/s experiment, the amplifier spacing was 140 km, and soliton control used synchronous amplitude/phase modulation. "Synchronous" means that the soliton pulse is modulated at each repeater in phase with the pulse train. This obviously involves a clock recovery facility within each repeater, which makes this technique more complex to implement than the sliding filter technique. However, as the very large repeater spacing and error-free performance over 20,000 km indicate, the performance advantage of synchronous modulation is quite interesting.

Significant work is still required to determine, according to specific system configurations (length, bit rate, number of channels, network functionality...), the preferred soliton control technique.

Submarine fibre optic networks

The conjunction of all the technologies described in the previous sections, has enabled the provision of very high capacity systems. For example, the TAT-12/TAT-13 ring network comprises two fibre pairs, each carrying a 5 Gbit/s signal.

In submarine systems, the telecommunications traffic density per cable is therefore becoming very high, and protection of traffic availability is an increasingly important requirement, from the user's point of view. Indeed, if no adequate redundancy strategy is implemented, the impact of cable cuts or equipment faults can be disastrous, as very large traffic payloads may be discarded, leading to operating inefficiency for telecommunications users.

Satellite back-up is phasing out as a viable re-routing option, as the capacity gap increases between fibre optic submarine systems and microwave satellite links. Therefore, submarine systems must offer an integrated solution to traffic availability and security requirements.

Several approaches are possible, depending on the likelihood of various failure scenarios. A basic approach consists in duplicating weaker elements of the network.

These elements can be terminal station equipment (terminal multiplexers, optical transmitter and receivers, etc.), for which automatic equipment protection switching (EPS) mechanisms can provide very fast correction of failures.

Another vulnerable element of submarine cable networks is the submerged cable itself. Despite sophisticated cable designs and elaborated cable protection procedures, such as steel armouring or burial under the sea bottom, submarine cables quite often suffer from fishing activity (fishing trawlers) and, to a lesser extent, from ship anchors in harbour areas.

Enhanced network redundancy scenarios have thus been developed to cope with the primary risk of cable cuts. One basic option is to duplicate cable routes, for example in a ring configuration such as TAT-12/TAT-13. However, to guarantee sufficient availability figures for priority traffic, the system capacity must be doubled, so that half the capacity is used for protection of the other half. This configuration is well adapted to small scale terrestrial networks using standard add/drop multiplexers (ADMs). It is not adapted to large scale submarine networks, as complex ADMs are needed in this case to avoid undue ocean back-and-forth transmission involved in standard ADM protection mechanisms.

Other schemes, based on protection of smaller units of traffic through digital cross-connects matrix re-configuration mechanisms, are generally preferred. This leads to the concept of network restoration, where the choice of an alternative path for a given communication channel, in the event of a failure (equipment or cable), is determined by "intelligent" algorithms implemented in the network management facilities that overlook the whole network and monitor network and equipment configuration, performance and alarm status.

This approach has the additional advantage of being compatible with the global deployment of SDH (Synchronous Digital Hierarchy) terrestrial networks, as SDH transmission concepts have been developed specifically to provide embedded network monitoring and control facilities.

All recent submarine systems are compliant with SDH and SDH-related standards, and the definite trend is to provide completely standardised transmission and management interfaces, so that submarine networks integrate within global network facilities.

Indeed, the management of submarine networks benefits from the technology and standards that have been developed for terrestrial networks. In order to fulfil the specific requirements of submarine operators, additional features have been incorporated in the recent breed of network management systems.

WDM networks

Expanding on the previous considerations on network protection, using wavelength-selective components in network nodes or branching units provides an additional degree of network flexibility. An immediate advantage of WDM is that, without increasing the number of fibre pairs, full connectivity can be offered even in networks comprising many nodes.

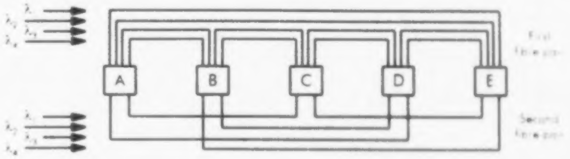


Figure 7 . Fully meshed regional network

Figure 7 gives a conceptual representation of a fully meshed network, where each node is connected to any other node, through a dedicated wavelength [7]. This type of architecture allows a good fit between capacity allocation and local capacity requirements, owing to the fine granularity offered by wavelength-division multiplexing. This finer allocation, and the absence of transit traffic, reduce the size of SDH equipment (multiplexers and digital cross-connect matrix) in node stations. For example, for a 8 x 2.5 Gbit/s system, the total line capacity is 20 Gbit/s but the traffic unit that can be affected to each node is a multiple of 2.5 Gbit/s. The fact that only dedicated traffic is dropped in a country implies a high level of traffic security and access sovereignty for each of the inter-connected countries.

Another topology enabled by wavelength-division multiplexing is depicted in Figure 8. In this type of regional network, all traffic transits through main nodes (nodes X and Y in Figure 8), and these hub nodes correspond to countries with higher capacity requirements, and focal geographical locations. This topology is well adapted when the intra-regional connectivity requirement is moderate and when most of the traffic is actually flowing out of the region.

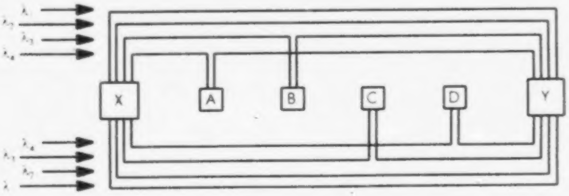


Figure 8 . Dual-hub regional network

Additional advantages of WDM networks include reduced requirements for equipment protection schemes, as wavelength re-routing features can provide traffic restoration facilities through wavelength route diversity, and the possibility of network evolution over time, as capacity allocation can be adjusted by changing wavelength allocation tables (or by transmitting additional wavelengths) when capacity requirements evolve. Thus wavelength-division multiplexing leads to greatly improved network cost-efficiency, performance and flexibility.

A key factor for the successful introduction of WDM networks is the timely availability of network management systems dealing with WDM specific features. For example, wavelength re-routing has a strong impact on the traffic management function usually performed in the SDH management layer. Performance and fault management functions must also be enhanced in order to monitor multiple wavelength channels in each node of the network.

Conclusion

Recent technological progress, including optical amplification, wavelength-division multiplexing and forward error correction, has enabled submarine systems with high capacity and performance to be designed and installed. Owing to these new techniques, enhanced functionality can be provided to the users of submarine networks: excellent transmission quality, very high availability, great flexibility and cost-efficient solutions.

Submarine systems are therefore evolving from point-to-point links to complex and high capacity networks, and the increased integration of submarine systems in the global network opens the path to worldwide global communications and services.

Acknowledgements

The author wishes to thank the many colleagues at Alcatel who contributed to the results presented in this paper, as well as the directors of Alcatel Submarine Networks for permission to publish this paper.

References

[1] S.S. Sian et al., OFC'95, San Diego, USA, February 1995, Paper PD26

[2] S.J. Pegrum et al., EFOC&N'95, Brighton, UK, June 1995, p. 123

[3] S.S. Sian et al., ECOC'95, Brussels, Belgium, September 1995, Paper Th.A.3.3

[4] D. Simeonidou et al., accepted for publication at OFC'96, San Jose, USA, February 96

[5] N.H. Taylor et al., OAA'95, Davos, Switzerland, June 1995, Paper PD7

[6] J.P. Hamaide et al., ECOC'95, Brussels, Belgium, September 1995, Paper Th.A.3.7

[7] M. Wehr et al., EFOC&N'95, Brighton, UK, June 1995, p. 93

THE DOMESTICATION OF THE WESTERN PACIFIC

Veronica M. Ahern
Nixon, Hargrave, Devans & Doyle LLP
Washington, USA(1)

1. ABSTRACT

The last five years have witnessed increased regulatory attention being paid to U.S. territories and possessions in the Western Pacific. In 1992 the FCC ordered the Guam Telephone Authority to comply with the regulatory requirements imposed on domestic local exchange carriers, despite the traditional international treatment of Guam and the CNMI. Since that time Guam and the CNMI have begun to seek the benefits -- as well as the detriments -- of domestic regulation. These include participation in the North American Numbering Plan and integration with U.S. domestic rates and services. If successful, their efforts could result in the creation of a U.S. domestic gateway in the Western Pacific.

2. INTRODUCTION

For most of the modern era, the United States territories and possessions in the Pacific have survived a telecommunications policy of benign neglect. Regulators seemed to care very little about what happened some 9,000 miles away from Washington. Then, in 1992, in a stunning and harshly-worded order, the FCC declared that Guam, and particularly the Guam Telephone Authority, were subject to its jurisdiction. It was declared that Guam was a domestic point, and that GTA must comply with the regulatory requirements imposed on domestic local exchange carriers.

Since that time, GTA and other entities in the Western Pacific have struggled to resolve the anomalies caused by the imposition of a domestic regulatory regime. If Guam and the Commonwealth of the Northern Marianas are domestic points, then should they not be part of the domestic numbering plan? If they are domestic points, then should they not be included within the domestic rate averaging plan? If the detriments of domestic regulation are to be imposed upon Guam and the CNMI, then, as a matter of fairness, should they not enjoy the benefits of domestication as well?

This paper describes the background and the issues surrounding the domestication of the Western Pacific. It recognizes that the problems will not be easily resolved, and that some international cooperation will be required. Nevertheless, the opportunities, not only for the people of Guam and the CNMI, but for the United States, are intriguing.

3. BACKGROUND

3.1 Guam

Guam is an unincorporated U.S. Territory some 8,800 miles from New York, 6,000 miles from San Francisco, 1,550 miles from Tokyo and 1,600 miles from Manila. It lies at the crossroads of the Pacific and is the social, political and economic hub of Micronesia. Because it enjoys a tropical climate, it is an excellent tourist destination. Indeed, Guam's economy relies in large part on tourists from Japan, Korea and other Asian countries. In addition, U.S. military personnel and dependents contribute significantly to the Guam economy. According to the Office of the Governor of Guam, almost 20% of Guam's population of 140,000 are persons associated with, or employees of the U.S. military.(2)

Since 1973, local exchange telephone service on Guam has been provided by the Guam Telephone Authority, a public corporation owned by the Government of Guam. GTA, with financial assistance from the Rural Utility Service (formerly the Rural Electrification Administration), has constructed a state-of-the-art fiber optic, digital network considered among the most sophisticated in the nation.

Until 1982, the sole provider of off-island communications was RCA Global Communications (now MCI). In that year a local company, IT&E Overseas, Inc., began providing service. IT&E has grown significantly so that now both IT&E and MCI have approximately the same percentage of the long distance market. Another important competitor is Sprint International which commenced service in 1994 and has quickly become a major carrier on Guam. In addition, Access Telecom, PCI Communications, Columbia Communications and JAMA Corporation are among smaller entities providing or intending to provide long distance communications.

Service to Guam is offered through the satellite facilities of INTELSAT, as well as through fiber optic submarine cables co-owned by U.S. and foreign entities. Recently, other facilities providers have been authorized to provide service to Guam. In 1992, the FCC authorized Columbia Communications to provide a full range of domestic satellite services, including circuits connected to the Public Switched Network (PSN) between the continental U.S., Alaska, Hawaii and Guam.(3) On November 3, 1995, the Commission authorized Guam Telecom, Ltd. to construct and operate a private fiber optic submarine cable between Guam and Hawaii.(4)

The sophisticated local network available on Guam, coupled with the modern facilities for service between Guam and the U.S. -- as well as the rest of the world -- provide a substantial opportunity for the creation of a Western Pacific gateway.

3.2 CNMI

The Commonwealth of the Northern Marianas lies about 50 miles north of Guam. It consists of a string of islands in the Mariana archipelago, the three largest of which are Saipan, Rota and Tinian. These three islands have a combined population of approximately 44,000 persons. Like Guam, tourism is a major source of employment in the CNMI.

Unlike Guam, the CNMI is a formal U.S. commonwealth, in political union with and under the sovereignty of the United States.(5)

Local exchange service in the CNMI is provided by the Micronesia Telecommunications Corporation (MTC), a 96% owned subsidiary corporation of the GTE Hawaiian Telephone Company which itself is a wholly-owned subsidiary of the GTE Corporation. MTC is not only the exclusive provider of local exchange service, it is also the principal provider of service between the CNMI and other points. In 1986, IT&E began operating in competition with MTC and recently other carriers, including MCI and Sprint, have begun providing off-island service.

Facilities serving the CNMI are microwave and satellite. Major cable facilities serve the CNMI through interconnection with Guam, which "serves as the Commonwealth's communications node to the domestic U.S. as well as the rest of the world."(6)

3.3 The Show Cause Order

Virtually from its inception, and until the events which prompted the present controversy, GTA provided service on an international rather than a domestic model. For example, the switching equipment used was not the standard domestic "Feature Group D" type, but rather a type used predominantly in international applications, CAMA/ANI.(7) Similarly, the charges for access were based upon a division of revenues formula, rather than the tariffed per minute of use (PMU) basis used in the domestic U.S.

Moreover, the carriers providing off-island service for both CNMI and Guam were licensed by the international, not the domestic, divisions of the FCC. They also provided, and continue to provide, service on the international model. That is, each carrier serving Guam has a correspondent relationship with a carrier serving the continental U.S. and these carriers divide revenue based on the accounting rate system used in the international arena.

The explanation for this unusual situation lies in three facts. First, until recently Guam and the CNMI were served only by facilities co-owned with non-U.S. entities. These facilities, INTELSAT and the submarine cables, were considered "international." Second, Guam and the CNMI are not included within the North American Numbering Plan, that process by which numbering issues affecting the United States and some 17 other countries are resolved. Guam and the CNMI, because of their distance from the continental United States, are not even in the same World Zone as the Mainland, Hawaii and Alaska.

Third, the arrangements for providing service to Guam and the CNMI had not been a matter of interest to regulators with larger, more immediate interests to consider. As a result the service arrangements evolved without any policy maker focusing on the potential problems, or the potential opportunities, in the Western Pacific.

That changed in 1990. Late that year IT&E filed an Emergency Petition for Declaratory Ruling, alleging that GTA was in violation of the Communications Act for failing to follow the access tariff regime which had been imposed upon domestic local exchange carriers. IT&E also sought to require GTA to employ domestic-style switching equipment and to convert to the standard Feature Group D protocol.

GTA argued, first, that it was a federal instrumentality outside the jurisdiction of the FCC. Second, GTA pointed out that it had traditionally been treated as an international point, that it had never participated in the domestic arrangements that preceded the access charge regime and that the Commission itself considered Guam an international point.

In 1992 the Commission made its decision. It found, with little hesitation, that Guam is a domestic point, that GTA is fully subject to the Commission's jurisdiction and that GTA must show cause why it should not file an access tariff like any other local exchange carrier.(8) The Commission left little doubt that it intended to exercise domestic-style jurisdiction over both Guam and GTA, but it did not address the problems of imposing a domestic regulatory structure on an overseas point almost 9,000 miles from Washington.

4. DOMESTICATION

The domestication of the Western Pacific began when the Show Cause Order did not address GTA's argument that its location served to distinguish it from other local exchange carriers. As time has passed the FCC has become more sympathetic to the anomalies of the Western Pacific. For example, it has tacitly permitted a delay in the imposition of the monthly $3.50 Subscriber Line Charge on Guam consumers. It has also allowed the temporary continuation of a system of subsidies that would not be permitted in the contiguous U.S. In the meantime, GTA has become more dedicated to seeking the fullest possible incorporation into the domestic regulatory regime so that its citizens would reap the benefits -- as well as the detriments -- of domestication.

4.1 The Integrated Compliance Plan

In April 1993, in response to the Show Cause Order, GTA filed an Integrated Compliance Plan (ICP) and an access tariff. The ICP proposed a gradual movement away from the division of revenues approach toward cost-based rates. It was intended that the six step process would be completed before 1998, however, a number of intervening events has caused delay. The first of these was the opposition of the interexchange carriers to GTA's initial effort to conform to the domestic structure, its choice of technology. After asking for and receiving FCC guidance, GTA announced plans to convert its system from CAMA/ANI to the Feature Group D protocol. IT&E and MCI objected, arguing that the international switching scheme had many consumer advantages. GTA agreed that CAMA/ANI had some attractive qualities, but maintained, in essence, that if GTA were to be required to operate as a domestic carrier, it should use the standard domestic protocol. Otherwise, Guam would always be struggling to adapt its system to FCC requirements developed in consideration of that domestic protocol.

In September 1994, the FCC agreed and ordered GTA to convert to Feature Group D "as soon as possible."(9) In particular the Commission recognized that FGD would allow Guamanians to avail themselves of the "full range of communications service features that can be provided elsewhere in the United States."(10)

4.2 Numbering

The second delay in the full implementation of GTA's Integrated Compliance Plan has been caused by controversies surrounding the inclusion of Guam and the CNMI in the North American Numbering Plan (NANP). The North American Numbering Plan is the basic numbering scheme that permits interoperable telecommunications service within the United States, Canada, Bermuda and most of the Caribbean. It developed from an AT&T plan in the early 1940's for the purpose of "the ultimate incorporation of all networks into an integrated network of nation-wide scope".(11) In its FGD Order the Commission addressed numbering issues and concluded that FGD could be implemented in Guam without also requiring that Guam be included in the NANP. It based this conclusion on the experience of successful implementation of FGD in the CNMI.

The Commission was correct that, strictly speaking, FGD implementation does not require NANP inclusion. However, implementation would require that Carrier Identification Codes (CICs) be assigned to Guam-based carriers to the extent that those carriers did not already use CICs for service in other points. In early 1995 IT&E expressed concern that CICs would not be assigned because Guam was not part of the NANP.(12)

Also in early 1995, the newly-elected Governor of Guam, Carl T.C. Gutierrez, became concerned that even the implementation of FGD would not fully bring Guam into the domestic telecommunications regime. In particular, he was concerned about preventing an asymmetrical dialing pattern in which Guam-originated traffic terminating in the rest of the United States would dialed as a "1+" dialing procedure and calls originated in the rest of the United States and terminating on Guam would be treated as international calls requiring a "01+" dialing procedure.

Clearly the solution to all these problems would be inclusion of Guam within the North American Numbering Plan. On March 1, 1995 the Governor wrote to the Director of NANP Administration and requested assignment of an area code and inclusion in World Zone One.(13) At first it seemed that this matter would cause little controversy. Indeed on April 20, 1995 the Industry Numbering Committee agreed to reserve 15 CIC codes for carriers servicing Guam.(14)

However, by mid-1995 it became clear that opposition to this aspect of the domestication of Guam and the CNMI would appear, primarily from Canadian interests. For example, on July 4, 1995 Teleglobe Canada listed its concerns, the most serious of which was "the potential threat of lost traffic and revenues."(15) Teleglobe anticipated that inclusion in the NANP of Guam and the CNMI would result in a significant reduction in rates between these points and the continental U.S., raising the possibility that "these islands could become telecommunications gateways to billions of potential Asian customers.(16)

Because of the opposition of Canadian entities, the inclusion of Guam and the CNMI into the North American Numbering Plan, which has the full support of the United States Government, has been delayed. It is expected that this issue, which has been raised to an inter-governmental level, will be resolved in early 1996. In the meantime, GTA is making plans to proceed with the implementation of its Integrated Compliance Plan based upon the inclusion of Guam and the CNMI within the NANP. Once the ICP is put back on track two of the three major steps to domestication will be taken: conversion to domestic technology and inclusion within the domestic numbering plan. The third and most important step -- integration of rates and services -- will be next.

4.3 Rate Integration

The Canadian response to numbering issues was caused not by concern over NANP inclusion but by a parallel event, the effort of the Governments of Guam and the CNMI to include Western Pacific rates and services within U.S. domestic rate averaging. On May 9, 1995 and June 7, 1995, respectively, the Governor of Guam and the Commonwealth of the Northern Mariana Islands filed Petitions to implement domestic rate integration to those points.(17)

Rate integration refers to the inclusion of U.S. offshore points within the uniform rate schedule based upon averaged costs and rates for most interstate services among points in the contiguous U.S.. Rate integration, which has been accomplished for service between Alaska, Hawaii, Puerto Rico/Virgin Islands and the contiguous U.S., is intended to promote interstate service between the Mainland and non-contiguous points at rates that are equivalent to those prevailing for comparable distances with the Mainland.

The essence of the petitions filed by the respective governments is that use of geographic rate averaging for some offshore points, and not for others, is inherently discriminatory. If Hawaii, Alaska and Puerto Rico are treated as domestic points for rate averaging purposes, what is the justification for excluding Guam and the CNMI?

It is also clear that the petitions are intended to take advantage of geography. The Governor of Guam foresaw that if Guam were the westernmost part of the United States for telecommunications purposes, then it could also become a significant gateway for Asian traffic. Not only would this have a beneficial impact on revenues and employment on Guam, it would also benefit worldwide consumers by increasing the potential for greater competition in the Pacific.

A number of parties commenting on the Petitions supported the desire to extend rate integration to the domestic Western Pacific. As could be expected, the interexchange carriers for the most part did not. These carriers benefit from the high rates between the contiguous U.S. and Guam and have shown little inclination towards reduction. Therefore, they argued that the concept of rate integration is "anachronistic"(18), that competition alone will serve to lower rates,(19) and that failure to include Guam and the CNMI is not inherently discriminatory.(20)

In response to these arguments, supporting commenters have agreed that times have changed since rate integration was initially required, but the domestic commitment to geographic rate averaging is still strong.(21) Further, competition has not appreciably lowered rates between the U.S. and Guam over the last several years.(22) Finally, a decision on whether failing to include Guam and the CNMI within the domestic rate pattern is discriminatory can only be made after a full hering.

The Petitions for Rulemaking are pending before the FCC. Action is not expected to occur quickly. Nevertheless, the signs of activism on Guam and the CNMI are very clear. It is expected that the Commission will be under some pressure to go forward with a rulemaking to consider rate integration.

5. CONCLUSION

The events of the early 1990's, particularly as they have involved Guam and GTA, all point to an increasing U.S. involvement in telecommunications matters in the Western Pacific. The decision to treat Guam as a domestic point, and GTA as a domestic local exchange carrier, has led to today's demands for full integration into the U.S. domestic structure. U.S. citizens in the Western Pacific are insisting upon the benefits, as well as the detriments, of domestic treatment.

Achieving domestication of numbering will likely require the cooperation of member countries in the North American Numbering Plan. Achieving domestication of rates and services will likely require an order of the FCC and the cooperation of the interexchange carriers. None of this will be easily achieved. But, as Teleglobe realizes, there is significant potential to create a telecommunications gateway in the Western Pacific, increasing access to all of Asia. Although prognostication is usually difficult, the power of that potential makes it easy to foresee the domestication of the Western Pacific in the next five years.

ENDNOTES

1. Ms. Ahern is Legal Counsel to the Guam Telephone Authority. The opinions expressed herein are those of the author and do not necessarily represent the views of the Authority.

2. Office of the Governor of the Territory of Guam, Petition for Rulemaking, File No. AAD 95-84, May 9, 1995, p.2 ("GovGuam Petition").

3. Columbia Communications Corp., 7 FCC Rcd. 6616 (1992).

4. Guam Telecom Ltd. L.C., 10 FCC Rcd. ____ (November 3, 1995).

5. See Covenant to Establish a Commonwealth of the Northern Mariana Islands in Political Union with the United States of America, 48 U.S.C. § 1681, Public Law 94-241 (March 24, 1976).

6. Commonwealth of the Northern Mariana Islands, Petition for Rulemaking, File No. AAD 95-86, June 7, 1995, p. 5 ("CNMI Petition").

7. Centralized Automatic Message Accounting/Automatic Number Identification.

8. IT&E Overseas Inc. and PCI Communications Inc., 7 FCC Rcd. 4023 (1992), recon. pending (Show Cause Order).

9. Guam Telephone Authority, 9 FCC Rcd. 4890 (1994). ("EGD Order")

10. Id., p.4892.

11. Administration of the North American Numbering Plan, 10 FCC Rcd. _____ (July 13, 1995), quoting Bell Laboratories Record, F.F. Shipley, Nationwide Dialing, p.368, October 1945.

12. IT&E Petition for Expedited Consideration, March 27, 1995, p. 8.

13. Letter of Carl T.C. Gutierrez to Ronald Conners, March 1, 1995. In addition, the Commonwealth of the Northern Marianas also requested inclusion within the NANP.

14. The INC is a standing committee of the Industry Carriers Compatibility Forum (ICCF) which exists under the auspices of the Carrier Liaison Committee (CLC) of the Alliance for Telecommunications Industry Solutions (ATIS). All of these organizations seek to resolve industry interconnectivity issues on a non-governmental, consensus basis.

15. Letter of Hubert Fournier, Teleglobe Canada, to Alfred Gaechter, NANP Administration, July 4, 1995.

16. Id., p. 2.

17. See notes 2 and 6 above. In addition, a similar petition was filed on May 1, 1995 by JAMA Corporation, a potential long distance competitor on Guam.

18. AT&T Comments, August 15, 1995, p. 2; GTE Comments, p. 6.

19. MCI Comments, August 15, 1995, p. 9.

20. Columbia Comments, August 15, 1995, p. 3.

21. GTA Reply Comments, September 14, 1995, p. 7.

22. Id. p. 5-6.

The Introduction of Direct-to-Home Satellite Services into Canada: When Policy, Regulatory and Business Strategies Collide.

Anthony H.A. Keenleyside
Partner
McCarthy Tetrault
Barristers and Solicitors
Ottawa, Ontario, Canada

ABSTRACT

The introduction of Direct-to-Home ("DTH") satellite services into Canada has been beset by confrontations between the government and its independent regulator. These difficulties have been compounded by business strategies of the potential providers of this service that have had direct consequences for limited satellite resources. Users appear to be an afterthought. This paper explores the background to the stormy introduction of DTH service and suggest that the chosen strategies of the various players may not have worked well---for anyone.

INTRODUCTION

The introduction of Direct-to-Home ("DTH") satellite based programming services into Canada has not been a smooth one. At the policy and regulatory levels, it has raised fundamental questions about the appropriate role of government in formulating the policy framework and that of the independent regulatory tribunal charged with implementing it. At the service provider level, it has also raised questions about the strategies adopted by the various potential providers of the service itself.

The entire introduction of this technology has been a microcosm of the PTC's theme of Users, Resources and Strategies. Initially, the process involved extensive battles between the government and the independent regulator over the preferred strategy for introducing the service. Both appeared to agree that market forces should play a greater role in delivering this service than has traditionally been allowed in broadcasting matters in Canada. Ironically, government felt that this could best be achieved through a strategy of regulation, while the regulator itself opted for an overall strategy of regulation, with exemptions in certain circumstances.

When that initial skirmish was resolved, the strategies of the potential suppliers of the service came to the fore. It rapidly became evident that their business strategies were to be the scorched earth, winner-take-all approach of incompatible set top decoders. This strategy had a direct impact upon resources. Canadian policy requires the use of Canadian satellites to deliver Canadian programming services to Canadians. As a result of this business strategy by the DTH suppliers, this policy could not be met, as there was not enough capacity on the Canadian satellites to carry all of the applicants fro DTH licences that ultimately appeared before the regulator.

And users? They appeared to be almost an afterthought in the minds of some. One DTH applicant asked the regulator to force cable subscribers to pay for the additional cost of satellite delivery caused by the repeated uplinking necessitated by incompatible technologies[1]. One programming undertaking fretted over what would happen "to the consumer that pays $1000 or more for a dish which, three months later [if their DTH supplier went out of business] , can only be usefully employed as a bird bath?"[2]. And both regulator and government made it clear that there would be little opportunity for users to receive any programming services from DTH suppliers that they could not theoretically obtain from cable providers.[3]

BACKGROUND

Since 1984 there has been a DTH licensing policy in place[4], established by the regulator, the Canadian Radio-television and Telecommunications Commission (CRTC)[5], but until the recent advent of digital video compression ("DVC") on a commercial basis, there has been relatively little interest in the policy. Moreover, at the time of its introduction, there was limited statutory ability on the part of the government to direct the regulator in policy matters.[6]

The CRTC's initial licensing policy with respect to DTH systems was to determine the manner in which the undertaking was operated. It did not matter whether the programming service that was provided was scrambled or not. Under this approach, there were two types of broadcasting undertakings for DTH only systems. The first was the so-called "conduit" which only delivered existing programming signals as received. In other words it did not produce or assemble any programming or alter the content of any signals it distributed. This undertaking would require a separate licence from the CRTC.[7]

The second type of undertaking was similar to a terrestrial broadcasting transmitting undertaking in which the operator produced, assembled or originated at least some of the programming.

With respect to already licensed undertakings, the Commission concluded that licensees which delivered authorized services by satellites under a network licence issued by the CRTC, would be permitted to deliver those services on a direct-to-home basis without any additional licensing action where the DTH service did not extend beyond the territory covered by the network licence.[8]

Similarly, licensees of existing over-the-air TV services could deliver that same service on a DTH basis without additional licensing action where the service was not distributed outside the original licensed service area.[9]

In either case, if the DTH service extended beyond the currently licensed service area, this would require an amendment to the existing licence.[10]

The Commission decided that it would not regulate subscriber rates for any DTH service.[11]

Largely for technological reasons, the CRTC's DTH policy generated virtually no interest for the first ten years of its existence.[12]

A NEW ERA-EXEMPTION FROM REGULATION

By 1994 a number of things had changed that made the concept of DTH much more attractive. Foremost of course was the advent of DVC which held the promise of squeezing multiple programming signals into one satellite transponder. This would effectively reduce the delivery cost per signal. This technological advance was coupled, on the regulatory front, with a number of changes as well.

In 1991, the existing federal *Broadcasting Act*[13] was completely overhauled and replaced. The new Broadcasting Act [14] gave the government the power to issue "policy directions of general application on broad policy matters" to the CRTC.[15] At the same time, the Commission was given new statutory authority to exempt undertakings from the requirement to obtain a licence[16], where the CRTC was satisfied that licensing would not contribute, in a material manner, to the implementation of Canada's statutory broadcasting policy.[17] The Act did not however give the Executive the right to alter or revoke an exemption order. As we shall see, the new power of direction on policy and the new power to exempt would soon clash head on.

In early 1994, the CRTC initiated a proceeding[18] in which it proposed to exempt from the licensing requirements of the Act, DTH satellite distribution undertakings, provided they adhered to a number of specific criteria, one of which was the following:

> "The undertaking makes use of Canadian satellite facilities to distribute programming services to viewers on a DTH basis".[19]

Although the wording did not explicitly state that such facility use was to be exclusively Canadian, it is apparent from the interventions received in respect of this proposal, that at least some key participants understood this to be the case.[20]

It should be understood that this requirement was not the result of a sudden bout of xenophobia on the part of the Commission. The proposal did nothing to alter the existing licensing regime which had been in place for approximately ten years. The Commission concluded that exemption was warranted, because the CRTC felt that licensing this type of undertaking would not make a material contribution to the Canadian broadcasting system.

The reasons justifying such a conclusion were that the exempt DTH undertakings would be required under the exemption criteria essentially to play by the same programming distribution rules as Canadian cable systems, that is, offer the same programming services, but with the added restriction that the exempt DTH players would also be limited to distribution of services using Canadian satellite facilities exclusively. Cable systems, which to this point had been granted on a monopoly franchise basis and were all licensed by the Commission, were permitted to receive U.S. originated signals (which were authorized for reception by the CRTC) directly from U.S. satellites; only Canadian originated signals had to be received from Canadian satellites.

Given the furore which subsequently erupted at the political level, it is worth noting that neither federal department responsible for broadcasting and telecommunications sectors in Canada participated in the exemption process initiated by the Commission.[21]

In August 1994, following the conclusion of this public process, the CRTC issued a final exemption order [22] which exempted DTH distributors from the need to obtain a licence, provided they adhered to specific criteria, one of which was that they use only Canadian satellite facilities.[23] Another criterion was that they meet the statutory Canadian ownership and control requirements.[24]

In order to drive home the point that the Commission expected DTH to be treated similarly to cable by programmers, the Commission stated in the public notice which accompanied the exemption order, that it expected "program and/or network undertakings to make their services available to the DTH undertakings at wholesale fees comparable to those offered to their cable affiliates".[25]

GOVERNMENT RESPONDS

Although the federal departments involved in communications in Canada had not participated in the process, within two weeks of the final exemption order being issued, they jointly announced a review of government policy.[26] This review invited comments from interested parties on a variety of issues related to DTH delivery in Canada and also created a three member panel to undertake a review of the DTH policy based on submissions that were received.

In early April, 1995, the body appointed to review the policy released its report[27], recommending licensing rather than exemption as an overall approach and the use of both Canadian and foreign satellites for delivery.

By this time there was in existence one potential DTH operator that could avail itself of the exemption order (ExpressVu Inc.) and one that -- by virtue of its proposal to use both Canadian and foreign satellites -- could not (Power DirecTv).[28] Both operators had powerful supporters with deep pockets.

ExpressVu was owned by BCE Inc., the holding company of Canada's largest telephone company Bell Canada; WIC Western International Communications Inc. and Canadian Satellite Communications Inc., both of whom were experienced broadcasting licensees; and Tee-Comm Electronics Inc., a manufacturer of DTH receive equipment.[29] Power DirecTv was 80.01% owned by Power Broadcasting Inc, in turn a wholly owned subsidiary of Power Corporation of Canada, a Canadian controlled public company, whose assets included a number of broadcasting undertakings, and 19.99% by DirecTv, the successful U.S. provider of DBS services throughout the United States.[30]

As noted, there is a provision in the new *Broadcasting Act*, which permits the federal cabinet to issue to the CRTC, "policy directions of general application on broad policy matters"[31] relating to the objectives of the broadcasting and regulatory policy set out in that Act. Prior to the DTH exemption order, this power had never been utilized.

The report of the policy review committee[32] included draft directions for the government to issue to the CRTC and one of the sections implicitly required the regulator, not only to revoke its exemption order and replace it with a licensing regime, but also to take immediate steps to ensure that no one provided DTH service without a licence.[33] The effect of that provision was to prevent ExpressVu from launching and providing its services pursuant to the exemption order, unless and until it received a licence several months later.

The government adopted the proposed directions. Under the *Broadcasting Act*, it was required to refer the proposals to two Parliamentary committees,[34] which it did. It also sought public comment on the proposals [35]and consulted with the regulator.[36]

The result was predictable. Everyone ran for a lawyer: the CRTC, ExpressVu, and several other interested parties. All affected parties appeared before both Parliamentary committees.

Opponents felt that the proposed directions to the Commission were an inappropriate exercise of the Cabinet's right to issue "policy directions of general application on broad policy matters" and also felt that the directions as drafted were illegal. The arguments supporting illegality generally fell into three categories: the directions were too detailed and not broad policy at all[37]; they had the effect of directing the revocation of an exemption order, something that the *Broadcasting Act* did not permit[38]; and as worded, the directions would have retrospective effect in that they would strip away the exemption order upon which ExpressVu had based its business plan.[39]

As an interesting footnote, it should be recorded that parties alleging illegality on the part of the government generally came armed with extensive legal opinions supporting their position. These included ExpressVu and the CRTC itself, whose legal brief was the most comprehensive condemnation of the government's interference with this quasi-judicial independent regulatory tribunal of all documents received.[40]

Conversely, the principal proponents of the direction -- the federal departments supporting them and Power DirecTv -- appeared before both Parliamentary committees completely bereft of any written legal support.

The government responded in part. It ultimately decided to issue directions to the Commission that toned down the degree of specificity and removed the retrospective application such that ExpressVu would be entitled to proceed under the exemption order during a transitional period. However it did not back away from its decision that a comprehensive licensing regime was preferable to the exemption regime put in place by the Commission. It directed the CRTC to call for applications to obtain licences for DTH distribution undertakings and for DTH pay-per-view undertakings as soon as possible and, in the absence of the "most compelling of circumstances" to complete this process no later than November 1, 1995.[41]

The directions as actually issued made it clear that, following this process, the exemption order was to disappear and be replaced by a licensing regime. This meant that ExpressVu could launch its services under the exemption order, but that following the licensing process, the undertaking would either have to be licensed or would have to cease to operate.

These developments raised several questions relating to the respective roles of government and regulator. There is of course the narrow legal issue of whether the government was acting within its authority. That matter appears to be moot however, since the directions have been issued and are being acted upon without legal challenge. There is however the broader issue of whether DTH service is better provided subject to regulatory oversight (licensing) or market discipline (exemption). Is the relatively small Canadian market large enough to support a competitive DTH environment in the long term and if not, who should make that call -- the government, the regulator or the marketplace?

THE LICENSING PROCESS

Four days after the directions were issued to the Commission, the CRTC called for applications for licences as directed. In response, applications for DTH distribution undertaking licences were filed by ExpressVu, Power DirecTv and a consortium of Canadian cable companies who had joined together with the US DBS operator Primestar in an undertaking called Homestar.[42]

BUSINESS STRATEGIES COMPOUND THE PROBLEMS

This prologue set the stage for the ensuing battle among the three would-be DTH protagonists. In keeping with the theme of this conference, their individual business strategies have direct consequences for the limited satellite resources available and ultimately for users of these services. It remains for history to judge whether these strategies were appropriate for Canada.

The DTH players form an interesting trio, particularly in light of their respective strategies. ExpressVu is presented as the "all-Canadian" participant, owned 100% by Canadian companies and using exclusively Canadian satellite facilities for delivery of its services. While this strategy may be appealing from a regulatory context, it creates limitations in the company's ability to deliver pay-per-view services, which may be the next wave of programming, since it will be limited to Canadian pay-per-view services or be required to re-uplink US based services that the CRTC may authorize.

Power DirecTv has aligned itself with DirecTv and its strategy is clearly to focus on pay-per-view services acquired from its US partner.[43] It also markets itself as the undertaking best equipped to counteract the so-called "grey market", namely, those Canadians who have opted to purchase satellite dishes and point them directly at US DBS satellites and receive this currently unauthorized service from---DirecTv! In order to offer this dual satellite service, Power DirecTv's Canadian programming must be carried on Telesat Canada's Anik E-2 satellite, which occupies an orbital slot close to the DirecTv satellite.[44]

Homestar is the cable-backed consortium. It too has aligned itself with a US DBS provider, Primestar. In order for Homestar's hybrid services to be made available, Homestar must carry Canadian services on Telesat's Anik E-1, close to the orbital slot currently occupied by the Primestar satellite.[45]

However, Homestar has problems. There is not and will not be sufficient capacity on the Anik E-1 satellite in the near future to accommodate both Homestar and ExpressVu.[46] Moreover, the Federal Communications Commission in the US has announced that it will auction off the orbital slot that Primestar had counted on for its "planned satellite" next year and has further issued a Notice of Proposed Rule Making[47] to the effect that it will propose pro-competitive restraints on DBS channel ownership, particularly by companies involved in other video distribution ventures---such as cable operators. This could well impact Primestar in a manner that would cause the CRTC concern in its current licensing deliberations.

Both the Canadian government and regulator are openly in favour of interoperable telecommunications architectures. In a DTH context, this means that a subscriber with the set top decoder required to receive DTH signals, could theoretically access any DTH service provider in some form of "pick and pay" manner.

However that is not the way the business plans of the three DTH providers -- ExpressVu, Power DirecTv and Homestar -- have evolved. There are numerous accusations of "closed" or "proprietary" system utilization being hurled about, but the fact remains that each DTH provider will utilize a set top decoder which is incapable of accessing the other provider's services. In ExpressVu's case, the equipment will be manufactured by one of its shareholders, while Power DirecTv will utilize a modified version of the system currently employed by DirecTv in the U.S. The cable consortium appears to be headed in yet another direction that, not surprisingly, is the choice of many programming undertakings that want to be compatible with satellite-to-cable delivery.

Both government and regulator have been unwilling to dictate a standard technology, partially out of concern for unduly favouring one participant, but mainly out of fear of choosing something other than the *de facto* standard ultimately preferred by the North American (essentially US) market. The government had recently been criticized for its choice of the CT2Plus standard fro digital cordless telephones in Canada, when it became apparent that this standard was not being adopted elsewhere, and the Canadian market alone was simply too small to produce acceptable market prices for the equipment.

The result of these DVC decisions is not without irony. Because it appears that one truly interoperable DVC technology will not be adopted for utilization in Canada, existing Canadian programmers are reluctant to opt for one technology over another for fear of ending up with the "wrong" technology and a substantial stranded investment.

Because these programmers are not moving to DVC as rapidly as some had anticipated, they are continuing to utilize analogue methods of delivery of their signal. This in turn means that they are not compressing these signals and that the anticipated freeing up of transponders on Telesat Canada's satellites has not yet occurred.[48]

In fact, this delay in the move to DVC by existing customers of Telesat Canada, led ExpressVu to announce in mid August that its anticipated early September launch of services would be delayed by up to two months because of a shortage of satellite capacity. Thus ExpressVu was caught in a classic trap, at least partly of its own making: it could not utilize the several month advantage granted it by the exemption order over Power DirecTv, because it was limited under that order to exclusive use of Canadian satellite facilities, which were not available because of the failure of DTH providers to agree on a DVC technology. Conversely, it could not operate with

285

foreign satellites, as this has always required appropriate licensing from the CRTC.[49]

There is another irony which relates to the programming that Canadian consumers will be permitted to receive from these entrants. Commission policy under the exemption order and the government's direction to the Commission both make it clear that DTH is intended to play by substantially identical rules to those imposed on cable.[50] Accordingly, neither type of undertaking will be permitted to have exclusive access to particular signals. This level playing field approach applies not only as between DTH and cable but also as between DTH providers themselves. Therefore, DTH customers may not have much to choose from in terms of actual programming, as between DTH suppliers, even if the famous set top box was in fact interoperable.

It has been argued by some that, aside from packaging and pricing strategies, it will be the pay-per-view services that determine the success of the DTH combatants. However, it is not apparent how this result will be achieved. The directions to the CRTC have made it clear that only licensed DTH pay-per-view undertakings can be carried on the DTH distribution undertakings and further, that the CRTC is directed by the government to prohibit the pay-per-view undertakings from acquiring exclusive or other preferential rights to pay-per-view distribution of feature films and other programming within Canada.[51]

It may be argued that Power DirecTv will have a significant pay-per-view advantage, by having access to DirecTv's pay-per-view arsenal, something that would presumably not be as readily available to ExpressVu. Although the DirecTv services could not be made available only to Power DirecTv on an exclusive basis under the government's direction to the CRTC, if ExpressVu or Homestar wished to access them, they would have to pay initial acquisition costs via DirecTv's satellite delivery and re-uplink them to the Canadian Anik satellite at additional cost for delivery to their customers. This would involve a cost not incurred by Power DirecTv and would not be a very efficient use of satellite resources.[52]

Here the regulator will have to tread with some care. It may interpret its mandate as directed by the government to permit unlimited access to foreign pay-per-view services, so long as they are not exclusive to one DTH undertaking and so long as there are appropriate windows for exhibition of Canadian content.

Conversely, the Commission may feel that this would be the proverbial camel's nose under the tent and that it would create irresistible pressure from Canadian satellite delivered services, to allow such services to be carried on U.S. satellite facilities.

The reason for this comes back to the issue of resources. In the absence of interoperability, Canadian programming services must be carried over the Canadian satellite facilities once by each of the DTH providers. Each provider must pay Telesat the cost of such delivery. Telesat's space rates are still regulated by the CRTC and the Commission has approved a three year window under which DTH space rates are heavily discounted from the regular space segment tariff rates.

The rubber will hit the road when the discounts expire (if they are not extended). For the cable consortium Homestar, this should not be an issue since it will use the same technology for delivery as the satellite-to-cable services; this means that there will be no extra uplinking and Homestar can piggyback on the existing arrangements.

ExpressVu and Power DirecTv will have to pay the full incremental costs of delivery using their own non-cable-compatible technologies. ExpressVu has stated that it is prepared to accept this additional cost as part of its business plan. Power DirecTv however, described this as a "deal breaker" in its application to the CRTC for a licence. It has proposed that all satellite delivery costs of all distribution undertakings--DTH and traditional cable---be pooled and somehow allocated on a per subscriber basis. Since cable companies in Canada currently have approximately 8 million subscribers and the largest anticipated total market for all DTH providers is expected to be less than 1.5 million[53], it is not difficult to see where the bulk of the costs would fall under this proposal. Not surprisingly, the cable industry was cool to this idea!

From the foregoing, it can be seen that the strategies of all participants in the DTH issue have, to some extent, backfired on them. The CRTC's exemption approach was portrayed by government as an incorrect policy conclusion that licensing a certain subset of DTH providers would not contribute materially to the Canadian broadcasting system. It was also characterized as being too directly favourable to one participant in that market (ExpressVu) at the expense of another (Power DirecTv). While the use of the government's power of direction may have been ham-handed and technically still of questionable legal provenance, the result nevertheless is a direction which has not been challenged and which has sent a fairly strong message to the CRTC about just how independent the government thinks this regulator should be on this issue.

As for the government itself, its initial attempts to control the regulator were generally universally criticized (except by those who stood directly to benefit from their implementation) as being clumsy and simply illegal. It also focused considerable legal scrutiny on a previously untested section of the new *Broadcasting Act*, a scrutiny which one hopes will result in more judicious use of this section in the future.

Finally, the protagonists themselves -- ExpressVu, Power DirecTv and Homestar -- through their DVC technological strategic decisions, have, in the short run, delayed the introduction of DTH service into Canada and have potentially set all Canadians up for a rerun of the best forgotten VHS - Beta battle of the VCRs a decade ago.

1 Application by Power DirecTv to CRTC dated August 25, 1995 for a direct-to-home distribution undertaking licence (the "Power DirecTv application"), section 5.1.

2 Allarcom Pay Television Limited intervention dated October 10, 1995, page 8.

3 This was evident both from the CRTC's exemption order criteria and the government's direction to the Commission, both of which are discussed in greater detail below.

4 See Public Notice CRTC 1984-195 dated July 26, 1984 and Public Notice CRTC 1987-254 dated November 26, 1987.

5 R.S.C. 1985, c. C-22 as amended.

6 Although the old federal *Broadcasting Act*, R.S.C.1985, c.B-9, contained a statutory policy statement in section 3, the government had no real ability to direct the CRTC on its implementation. Moreover, the government's ability to review decisions of the CRTC was limited in section 14 to setting aside or referring back to the CRTC for reconsideration the "issue, amendment or renewal by the Commission of any broadcasting licence..."

7 Public Notice CRTC 1987-254, *supra*

8 *Ibid.*

9 *Ibid.*

10 *Ibid.*

11 *Ibid.*

12 There was some DTH service provided at C-band frequency, but success was relatively limited.

13 Endnote 6, *supra*.

14 S.C. 1991, c.11 as amended.

15 *Ibid.*, section 7(1).

16 *Ibid.*, section 9(4).

287

17 Set out in section 3(1) of the new Act.

18 Public Notice CRTC 1994-19 dated March 2, 1994.

19 *Ibid.*, criterion 3 of the proposed exemption order attached to the Notice.

20 In its April 15, 1994 comments in response to the proposed exemption order of the CRTC, Hughes DirecTv Canada, Inc. objected to the proposed restriction to the use of Canadian satellite facilities only. See pg.8 of its submission.

21 In broadcasting matters, the responsible government department is Canadian Heritage; in telecommunications it is Industry Canada.

22 Public Notice CRTC 1994-111 dated August 30, 1994.

23 *Ibid.*, criterion number 3.

24 *Ibid.*, criterion number 1.

25 Endnote 22, pg.5.

26 The Ministers of Canadian Heritage and of Industry announced the review September 12, 1994; a formal policy discussion paper appeared in the Canada Gazette November 26, 1994 at pg.4505.

27 The report was released in April 1995 and was entitled *"Direct-to-Home Satellite Broadcasting: Report of the Policy Review Panel"*.

28 As events transpired, it turned out that Power DirecTv was not a legal entity and the actual licence application was filed by its chairman on behalf of a company to be incorporated.

29 ExpressVu DTH distribution undertaking licence application dated August 25, 1995, Schedule 6.

30 Power DirecTv DTH distribution undertaking licence application dated August 25, 1995, pg.5.

31 S.C. 1991, c.11 as amended, section 7(1).

32 Endnote 27, *supra*.

33 The Report recommended, at pg.38, that the CRTC should be directed "to take, immediately on the coming into force of this Order, all necessary and appropriate steps to ensure that no person is authorized to carry on a DTH distribution undertaking by any means other than a licence".

34 S.C. 1991, c.11 as amended, section 8(2). The proposed order was referred to the Standing Committee on Canadian Heritage of the House of Commons and to the Standing Senate Committee on Transport and Communications.

35 Endnote 26, *supra*.

36 Under section 8(4) of the *Broadcasting Act*, the appropriate Minister must "consult" with the CRTC regarding any proposed order before it is laid before Parliament an referred to the relevant committees. In fact, the CRTC was asked on Friday April 21, 1995 at 10:30 a.m. to have its comments to the Minister by Monday April 24, 1995 at 11:00 a.m.

37 As an example, the proposed order would have required the CRTC to impose "the same rules" on DTH providers as exist for cable companies, something that is literally impossible to do in the context of cable "must carry" rules.

38 Endnote 32, *supra*.

39 *Ibid.*

40 See *"Brief of the Legal Directorate of the Canadian Radio-television and Telecommunications Commission"* to the Standing Committee on Canadian Heritage dated June 6, 1995 on Proposed Orders-in-Council P.C. 1995-619 and 620.

41 Paragraph 7 of the final order, entitled *"Directions to the CRTC (Direct-to-Home(DTH) Satellite Distribution Undertakings) Order"* (hereafter "the DTH Direction"), attached to P.C. 1995-1105 dated July 6, 1995.

42 Direct broadcast satellites (DBS), which are utilized in the US typically are significantly higher powered satellites (120-240 watts) than the Canadian satellites used for direct-to-home (DTH) purposes (50 watts). However, the concept of delivery direct to the subscriber is the same.

43 Power DirecTv proposed "approximately" 63 English and 1 French pay-per-view channels (application pg.6); Homestar proposed 16 channels (application pg.5-2); ExpressVu proposed "at least" 30 channels in English and French (application, Schedule 31, pg.17).

44 The Power DirecTv proposal includes the Telesat Anik E-2 at 107.3 degrees W and three Hughes HS-601 satellites located at 101 degrees W. See Power DirecTv application pg.6.

45 The Homestar proposal includes the Telesat Anik E-1 at 111.1 degrees W and Primestar's "planned satellite" to be located at 110 degrees W. See Homestar application pg.4-2.

46 At the licence hearing, Telesat Canada gave evidence to the effect that it expected to have available 6 and possibly 7 appropriate transponders on Anik E-1 as of January 1, 1996 and that this number could increase to a maximum of 10 within a year. ExpressVu's application indicated that that company required 9 transponders, moving to 10, while the Homestar application indicated a requirement for approximately 3.5 transponders in total.

47 *Satellite Business News*, November 1,1995, pg.1.

48 For example, at the DTH hearing before the CRTC, witnesses for Telesat Canada indicated that a large majority of satellite-to-cable programming undertakings wanted to be cable compatible and thus would adopt the cable preferred General Instrument Digicipher-2 technology. Some undertakings were moving to adopt the Digicipher-1 technology which is completely proprietary, while others were awaiting the arrival of the MPEG-2 compliant Digicipher-2 system, expected to be available in the latter half of 1996.

49 As events transpired, ExpressVu was ultimately unable to start taking orders until November 15, 1995, with commercial delivery not anticipated before the first quarter of 1996.

50 See criteria 5 and 7 in particular of the CRTC's exemption order and paragraph 4(a) of the DTH Direction.

51 See the DTH Direction, paragraphs 4(d) and (e).

52 In addition of course, the acquired services would undoubtedly include promotions for the competing Power DirecTv service!

53 ExpressVu estimated the total DTH market in Canada at 1.1-1.2 million homes (application, Schedule 31, pg.30); Power DirecTv estimated that it could attract about 400,000 subscribers over 7 years (application pg.13); and Homestar put the total potential DTH market at approximately 693,000 (application--Homestar DTH Financial Model, pg.5).

The Informatization of Japan: Creating an Information-Society, or Just Good Salesmanship?

Jonathan M. Jaffe
Keio University
Fujisawa, Japan

This abridged version of an earlier research paper examines the phenomenon of "informatization" inside of Japan. Specifically, I have tried to uncover the reasons for the governmental push towards establishing an information-based economy, and the methods used to reach this goal.

Introduction

The Ministry of Posts and Telecommunications (MPT), Ministry of International Trade and Industry (MITI) and periodically the Prime Minister's Office of Japan—hereafter collectively referred to as the state—are actively promoting Japan's 'informatization.' Informatization, in the state's rhetoric, means the process of making Japan an 'information-society.' The term information-society is employed by the state specifically to refer to a society in which the social structure is based upon information-oriented institutions rather than the materially-oriented ones of the industrial-society. Furthermore, in the discourse of information-society there are promises of a vastly improved society in which creativity replaces the mundane, harmony replaces conflict, and spiritualism replaces materialism. In short, the Japanese state says that it is promoting the transformation of Japanese society through promoting Japan's informatization.

Part I

The Incentive to Informaticize: Jōhōka *and the Information-society*

What is informatization, and what is an information-society? *Jōhō shakai*, (情報社会) translated as 'information-society' generally connotes a society in which the community is revitalized, intellectual creativity flourishes, peace prevails, Japanese culture becomes internationally respected, and harmony with nature is attained. It is important to recognize that *Jōhō shakai* does not reflect some of the discourses implied by the term 'information-society' as it is used in some other nations, discourses such as democracy, equality, individualism, free expression, decentralization of government, increased political participation, high economic growth, or jobs. *Jōhōka* (情報化), hereafter called informatization means the complex process of becoming an information-society. The informatization process must include certain events and actions if an information-society has any chance at all of being achieved. In the most tangible terms, informatization must encompass everything from the laying of fiber optic cables to the creation of medical data banks, public investment in new education programs, ubiquitous use of telecommunication devices, creation and explosion of the bio-technology industry, and so on. In other words, informatization is the actual process of manufacturing the tools that the state promises will lead to an information-society. Informatization is not, however, necessarily the process of creating an information-society.

Informatization occurs as an economy moves from being industry-based to becoming information-based. Whether it be making computers ubiquitous, replacing factories with information production centers such as software houses or bio-technology laboratories, or creating major socio-technological changes, informatization requires an economy to shift emphasis from the industrial era's industrially-orientation to information-oriented industry. While most sources of informatization-promotion in Japan emphasize the social implications of moving into an information-age, the move is made real only as the economy shifts its center from industrial production to information production. This is because any information-society concept, in fact, assumes the establishment of information-oriented products, such as multi-media, as ubiquitous items of consumption. I define informatization to be the process of moving from an industrial economy to an information-centered economy. This definition is free of the rhetoric about the shape of a transformed society, while at the same time it embraces an aspect crucial to any societal transformation—its economic foundation. I do not use informatization to mean the creation of an information-society. The distinction is an important one.

Jōhōka *for the Welfare Society*

In the last fifteen years the state has solidified its discourse on informatization. What was a vaguely recognized concept in the sixties has become a highly refined and consciously directed method of promotion in the nineties. The justification for Japan's informatization policies increasingly take on the guise of promoting the welfare society, a paradigm for a society that transcends the modern state and its [illegible] consumption, in the [illegible] policies which are geared towards the improvement of the 'quality of life' of the Japanese, and are directed away from the old patterns of promoting high-economic growth through mass-consumption, self-sacrifice and tolerance of undesirable living conditions. The state's promotion of informatization relies upon the idea of a welfare society by embodying its promotion in the concept 'information-society.' MPT's report *For Achieving Globalization of an "Intellectually Creative Society"* says, for example:

> An info-communications infrastructure should be considered the most important social capital in achieving globalization of an intellectually creative society, as we prepare for the paradigm shift from mass consumption to qualitative improvement in individual life styles.[1]

If it is the case that the state intends to transform the foundation of society to one which emphasizes the quality of life rather than the consumption of goods, we expect to see policies aimed at initiating some of the state's pronouncements. In the policy outline reports, however, ideas are scant, and actual implementation is all but nonexistent. Instead, the state concentrates on a different sort of policy: providing research and development incentives to information-oriented industries. Some examples in the subsidization of Japanese computer science students to study in the US in order to learn the advanced programming techniques[2]; providing money to research and development centers and distribution houses[3]; giving Official Development Assistance (ODA) money to developing nations which is intended to find its way back to Japan. Such policies reflect the status quo, not a fundamental shift towards a welfare state.

The emphasis of various policies and laws are reflected in the views of one MITI bureaucrat who "believes the government's first priority should be to act as a 'catalyst' or 'incubator' for industry."[4] But this need not necessarily mean the state has no interest in making Japan a welfare society. It can be argued that the state takes an active part in creating markets for information technologies because the proliferation of the information industries will eventually lead to the increased welfare benefits promised by the state. And because consumer demand is crucial to the process of informatization—without the complicit participation of citizens purchasing the products of information technologies and information services these industries cannot survive—the state cannot be faulted for promoting demand. Hence, the state must create policies to increase demand if it wants to increase the welfare of the nation's people. But Morris-Suzuki's casts serious doubt upon the promises of increased quality of life when she argues that rather than expecting increased creativity through informatization, there are reasons to expect an overall decrease in the intellectual stimulation of the work place. She also argues that women will take the brunt of negative changes in both work and social spheres, and she proposes a model of increased centralization of business and state power which seriously endangers personal freedom and privacy.[5] Clearly, there exists the possibility of developments antagonistic towards a welfare society, yet policies—even committees—to counter the possibility of undesirable trends are patently absent from the informatization arena. Private groups organized specifically to address these problems are blatantly ignored by the state. Despite the state's active promotion of informatization as crucial to the welfare of the people of Japan, such welfare-oriented policies are conspicuously absent from the state's agenda as is an interest to understand what informatization may *really* hold for Japanese society. At the same time production of policies aimed at increasing development and consumption continues. The essential reason the state propels the nation towards informatization seems to be for the economic value. This has everything to do with the value of information.

The Value of Information

On a national scale, the importance of information to a nation's economic health is tremendous, particularly the more advanced the nation. In Japan, MPT has recognized both the current value of information technologies, and the expected value of it in the future.[6] MITI, too, is highly aware of this: "the government as a whole has become well aware of the importance of information technology, and policies have been noticeably redirected toward promoting such technology,"[7] supporting the assertion that the Japanese state's informatization policies are directed towards cultivating the information sector of the Japanese economy. Naturally, the state is concerned with the economics of informatization: the information industry is worth a lot of money.

The value of informatization is not only measurable in economic increments. There is also the value to the individual state members in terms of maintaining and enhance their own power and influence. This is particularly true for MPT and MITI as they battle it out to gain control over the emerging industries, not to mention maintain their own relevance. As information and information industries become more important to the nation it follows that the members who have been fighting for control over one another for the last century—bureaucracy, politicians and business—will try to establish themselves in this new area. As an example, even while 'letting go' of NTT in 1985, MPT is having a tough time relinquishing control over the phone giant for fear that MITI will move in and fill any vacuum left.[8]

This comes as little surprise in light of Chalmers Johnson's investigation and analysis of how the ministries—MITI in particular—work to enhance their own importance to information industries so as to secure candy cane positions for their members with the practice of *amakudari*, as well as to be able to exert control over the direction of the nation.[9] Various pressures push the ministries to deregulate while at the same time the bureaucracies come under fire for administrative guidance. In this atmosphere they legitimately fear their own castration. If they lose their place of importance by losing their influence in industry, they lose that which legitimates their existence and offers them important perks such as *amakudari*. It is not difficult to imagine the excitement of both MPT and MITI, too, when the LDP was dethroned in 1993, for as *zoku* members lost some of their influence among vested interests and the ministries, MPT and MITI were probably able to increase their influence in relation to the ebbing of *zoku* control. The recent establishment by both ministries of various low-interest loan policies and procurement orders, for example, are attempts to establish themselves in positions of power as much as they are attempts to increase the growth of the economy's information sector. Such incentives to industries to increase production, while benefiting the targeted companies and industries, also give the particular ministry responsible a say in how and in what manner a product will be developed. The abundance of policies that place the state front and center in Japan's informatization are attempts to replace lost soil eroded by deregulation and resistance to administrative guidance, giving us more reason to be suspect of the state's overture to make Japan an information-society.

Part II

Information-society as a Promotional Tool

The state, in order to promote informatization, has seized upon the concept of the information-society. Even though the rhetoric used rarely invokes ethnocentric terms of comparison between Japanese and others, the information-society concept relies upon ideas of what it means to be Japanese. At first glance, the ideas of community, creativity, ecology, and peace appear to be near universal concepts applicable to any nation or people. But part of the information-society discourse is to couch these themes in terms of globalization and internationalization, discourses which in and of themselves are grounded in forms of nationalism.[10] It is rare to find promotion laced with terms 'Japan' or 'Japanese.' Instead, white papers and committee reports say things such as *the world* will become an information-society, informatization affects the *global* society, and developing *and* developed nations will benefit. In other words, binary pairs common to most discourses on Japan such as Japan/America, Japanese/Westerners or us/them are all but absent. This adds to the impression that informatization means internationalization, a sub-theme of the information-society discussed in the section on promotion of Japanese culture. The state seizes upon this seemingly global concept of the information-society but it is a discourse particular to Japan. The development of the information-society themes of creativity, community, ecology, harmony and promotion of Japanese culture, however, is not solely attributable to the state, just as disseminating the information-society concept is not solely undertaken by it either. The state has an intricate relationship with 'agents' in its endeavor to promote informatization.

The State and its Agents

Before talking about the relationship of the state and its agents, I must mention that there is another party involved. It is private business. Unfortunately, due to considerations of space and complexity, this player in the game of informatization promotion must be ignored.

What are 'agents?' Most, if not all, are men affiliated with respected universities, public or private, in which they hold tenured positions. They are not employed by the state as spokespersons. They have established independent, respected careers. Their professional work focuses primarily on aspects of informatization. And most importantly, they actively promote Japan's informatization.

There are three reasons why the state is interested in employing agents. Firstly, the state and the agents share the goal of informatization, even though the agents alone maintain the interest in creating an information-society. Secondly, the agents' articulated rationalizations for informatization are grounded in the respect they have earned. Finally, the independence of their positions offers legitimacy to the state's goals in the eyes of the public.

The relationship between the agents and the state goes like this: private individuals employ effective methods to promote informatization. The state then both uses these methods in their own publications, reports and policy outlines, and encourages the continued private promotion of informatization by means of financial and organizational assistance to the agents. The state also brings the agents directly into the policy-making process, thereby adding legitimacy to the government publications. Essentially, the agents and the state have a relationship in which the goals of both parties to informaticize Japan intersect. Because the agents' methods of promoting informatization seem to be the most effective, the state both incorporates the agents into committees which generate reports for the public, and supports them in their own endeavors to promote informatization.

The Discourse of 'Information-society': Culturalism

Culturalism, here, is a subscription to ideas about what constitutes essential Japanese identity. In other words, if the Japanese state justifies informatization through culturalism, it is justifying informatization by appealing to beliefs about what it means to be Japanese. My argument here is that the concept of *jōhō shakai* is grounded in culturalism, and this is the fundamental reason this concept is used to promote Japan's informatization.

But first the question arises, why does the state not emphasize an economic liberalist approach in promoting informatization? Why should it not make an argument such as, "Japan must informaticize because informatization will fuel our competitive engine?" One significant reason is that the image of Japanese as economic animals is not palatable to the public. The Japanese became "highly sensitive" to this image following heavy criticism of the Japanese for being concerned only with increasing their global market share and not with their global responsibility. Nakasone reflected this sensitivity in his endeavor to develop an internationalist strategy for Japan. During the Gulf War crisis, Japanese criticized their government for having no post-Cold War ideology; that economics was all Japan knew.[11] Ultimately, at a time when the Japanese have been trying to reshape the image they portray to the world and to themselves, the promotion of informatization by using economic justifications could prove repugnant to the public and draw heavy criticism from various circles, having the effect of countering the state's intentions.

The other reason for not relying upon economic arguments is the increase in affluence and wealth of the Japanese, particularly over the last 25 years. The increased satisfaction with the financial state of people's lives over the last two-plus decades has decreased the relative importance of the economy in the minds of the Japanese compared to, say, the Americans, where significant unemployment and a leveling off or decrease in living standards has made the economy a paramount concern to the majority of citizens.[12] The Japanese economy has enjoyed substantial and consistent growth since informatization first became a serious concern of the state, not withstanding the recent economic slowdown. The unemployment rate continues to hover below radar detection,[13] there has been a marked increase in people's positive attitudes towards their standard of living, and people's satisfaction with society in general has increased significantly.[14] In consideration of this, and in contrast to the issues of unemployment and perceptions of pejorative living standards in the United States, it is easy to see why economic justifications for informatization employed in the US are not going to be as effective in Japan. In order for the state to convince consumers of the benefits of informatization and excite consumption in Japan's information market it must find a more effective justification than economic growth.

So despite the slow economy of recent years, justifications for informatization created by agents and used by the state focus upon seemingly humanistic benefits. Economic justifications are used, but they are de-emphasized, especially in comparison to the non-economic reasons stressed. This accounts for the promotion *not* by appeals to economic concerns, but rather through promises of intellectual creativity, community, ecology, peace and harmony, and self-determination of how the world thinks of the Japanese. These are the themes of *jōhō shakai*, Japan's information-society. It also accounts for the theories used such as Kumon Shumpei's 'co-emulation' theory to explain the formation of the information-society, discussed later.

The Themes of the Information-society

Intellectually creative society

As of late, one of the political slogans used by MPT in promoting informatization is 'intellectually creative society.' It constantly appears in various reports and guidelines concerning informatization, constituting the first theme of 'information-society.' MPT writes that an intellectually creative society is, "a society that encourages individuals to freely conduct a diversity of intellectually creative activities."[15] Although vacuous, the tune that informatization will foster creativity is played up.

In Japan the appeal of creativity takes on bloated significance. A component of *nihonjinron* is the idea that Japanese are not inherently creative people, and certainly it cannot be denied that in the incessant bipolar comparisons of Japanese and Westerners, the issue of creativity often serves as a point of self-deprecation on the part of Japanese, expressing a conviction that Japanese are not typically creative people. Kumon notes that "Japanese have been virtually stereotyped as lacking in breakthrough-type creativity."[16] Such expressions surface in talk about music creation, software production, art, science and even literature despite evidence to the contrary. In light of the valuation of creativity as positive and yet lacking in Japanese society, the argument that informatization fosters human creativity becomes a strong selling point to the public. In essence it means that: now having succeeded at learning the methods and technologies of Western countries, we can become a fulfilled people by cultivating creativity, then develop our own methods and technologies. *Jōhōka*, therefore, becomes a means to develop the qualities lacking in the Japanese 'race.' The call to creativity through informatization is a call to improve the 'national character' of the Japanese because it resonates with firmly held ideas about who the Japanese are. It is a culturalist argument. It is understandable, then, when Masuda Yoneji predicts a flourishing of creativity in an informaticized Japan. His influential ideas have both defined the state slogans—*For Achieving Globalization of an Intellectually Creative Society*—and laid the foundation for the ideas of other agents in their promotional activities—*Creativity and Constructive Co-Emulation During the Great Transformation*.[17] The state and its agents use the justification that informatization increases intellectual creativity in particular because it appeals to the culturalist sentiment that Japanese need to become a more creative people.

Community

Another descant in the informatization repertoire is the creation of community. MITI writes the "progress of informatization will spur this movement for formation of new communities....[T]he role of the regional community will assume greater importance as a base that compensates for domestic life."[18] The idea of community has special value to the Japanese, and this idea is used by the state as a culturalist appeal to informaticize. This accounts for the heavy reliance upon the 'increased community' argument in both the state and agent rhetoric of informatization.

In Japan, 43% of the population lives in the three urban areas of Tokyo, Osaka and Nagoya. The hyper-urbanization of these regions has been a growing concern of the Japanese. People's complaints about outrageous land prices, numbingly long commuting times, and crime and alienation are repeatedly echoed in the media. These complaints are amplified by arguments for informaticizing because informatization is seen as a partial solution. The idea goes that, with a hyper-media communications network fully integrated into society and an information-based economy employing the majority of workers, physical location of where one works loses importance. Since distance and time delays are essentially nullified when it comes to transferring information—be it research data, orders for goods or visual communication— organizations can avoid the high land prices and other undesirable elements of over-crowded cities, allowing them to move to less densely populated areas where operational expenses are lower. In addition, tele-commuting will become popular, allowing people—mothers in particular—to work from home and therefore be closer to their children and parents. The ultimate consequence, it is argued, will be a strengthening of community and of family because people will live closer to where they work and will enjoy more free time.[19] This has a strong appeal to the ideas of tradition where the family in general and the mother in particular are rooted and established at the home, and the home in a community of other such homes.

It is not just the day-to-day living that makes the idea of leaving the city desirable. There exists the allure of the socially oriented community where the bonds once broken by the solitude of living anonymously among hundreds of thousands of other unknown souls are gently mended through revitalized contact with one's neighbors and family members. The attraction of living in a community in which everyone has a stake and in which everyone contributes is strong. It conjures up images of the idealized sense of community in the archetypal agricultural community that is the foundation of essentialist ideas like Japan as an *Ie* society and Japan as a rice culture; ideas given legitimacy by state representatives as well as highly respected academics. To make an appeal to community is to make an appeal to being truly Japanese. In this sense community serves as a selling point for informatization.

A common current of *nihonjinron* which also supports this idea of community and Japanese is the idea that Japanese are 'contextualists:' they function not as individuals but rather as transfigurable creatures who take the shape of their surroundings, and that this fundamental characteristic is crucial in explaining the 'national character' of the Japanese people.[20] Hamaguchi, in arguing that the Japanese are inherently contextualists whose identities depend upon the context in which they find themselves says, "in Japan, who is 'I' and who is 'you' is not defined absolutely, but is always being defined according to the nature of 'I' and 'you' relations."[21] The logical conclusion of this reasoning is that Japanese do not have individual identities, nor do they have absolute, stand-alone selves. Here is where the connection between contextualism and community can be made. If one is a 'contextual', using Hamaguchi's terms, as opposed to an individual, then it follows that one will desire to be surrounded by others in a community. Without a community in which to form an identity, one would be 'self-less.' Consequently, the community argument ought to have strong appeal to the Japanese and ought to be effective in promoting informatization. Kumon himself has written much about the Japanese as contextualists.[22] His recent writings on Japan as a 'network society', discussed later in this paper, appear to derive from the contextualist theory. Although neither Hamaguchi nor Kumon speaks directly about community, it is not difficult to infer from their writings that they believe that Japanese are community-based people. To be 'a contextual', to not have an absolute self but rather an identity based upon context, and to have a need to live as a member of a group is essentially to have a need for a community. Their arguments reveal assumptions that Japanese are inherently community-oriented people unable to fully exist outside of some communal group. This, then, explains the emphasis upon community development in the information-society.

Environmental Appeal

Another popular component of *nihonjinron* also used as a theme for the information-society is that the Japanese have an intimate and harmonious relationship with nature. Examples can be found in the works of prominent Japanese media figures such as Umehara Takeshi, the first director of Nichibunken in Kyoto and well-known author and academic. Umehara, asserts that Japanese are fundamentally different from Westerners in their relationship to nature. In contrast to the Westerners' beliefs that nature is to be dominated, Japanese believe that, "human beings share life equally with plants and animals."[23]

The popularization of such essentialist beliefs reflect my own experience of many Japanese telling me that because they are Shintoists they respect nature and always strive to live in harmony with it. It should not be surprising then to find that another important method used to promote informatization is the appeal to ecology. These arguments first find their way into the information-society discourse when MITI writes, "it is necessary to promote the change from industrialization, which is the extension of old concepts, to new informatisation by the plan for an information society, *because world resources are limited*."[24] We do not blink when subsequent state publications such as *Info-communications in Japan 1994* carry such sub-headings as "Creating an Environment-Friendly Society," despite the fact that they contain no substance in the area of environmentalism. The most stalwart proposal made to date has been to "protect the environment by installing cables underground" which seems more important for aesthetics than for protecting nature.[25] A lack of any real agenda to protect the environment has not slowed the call for informatization as a means to greatly improve the environment, however.[26] Ecology has become the third theme of the information-society because the promise that an information-society lives in harmony with the environment is an appeal to a commonly held perception of what it means to be Japanese. It both enhances and depends upon the discourse of an essentialized Japanese identity. It is not that ecological themes are found only in Japanese discourses on the information-society—some in American and European green movements also say that informatization is a partial remedy for environmental ailments—but the Japanese discourses go beyond these general appeals by implying that informatization resonates with what it means to be Japanese.

Peace and Harmony

Not withstanding the 'anomaly' of the last World War—or perhaps because of it—the Japanese have set about to convince the world, and convince themselves, that they are a peace-loving nation. It is not surprising to find that yet another motif of the information-society is 'peace and harmony.' An MPT press release says:

> As the 21st century dawns, information infrastructures will be accepted as humanity's most important assets for overcoming global problems, and the development of such infrastructures through international cooperation will acquire growing importance.[27]

And it writes in its report on an *Intellectually Creative Society* that an information-society is, "a society of peace and harmony based on mutual understanding and respect."[28] It is worth noting that these vague promises never become more specific; they do not clarify how harmony or peace will be established, nor do they offer any solutions for human conflict. They do not explain how impoverished nations such as Thailand, a recipient of ODA for communications development, will benefit. In other words, the peace and harmony is an empty slogan.

That does not mean, however, that this theme is unsuccessful. To see how this pitch for the information-society has taken hold, we only need look so far as the Internet. Establishment of world peace by means of informatization is a surprisingly common theme in Japanese newsgroups, World Wide Web 'home pages' and on-line 'chat' discussions. One Japanese participant, in reference to Stanford University's *Japan Window* home page writes, "I sincerely hope this kind of internet [*sic*] *www* project will thrive on earth using the information super highway. Better communication between the kids will definitely contribute to the peace on earth."[29]

The reason the information-society discourse incorporates the idea of peace and harmony is because of the strong belief of *wa* (和) as an essential characteristic of Japanese identity. Takigawa Hirō exemplifies this when he writes, "it is thought that *wa* has operated as a principle of social organization since Shōtoku Taishi."[30] As Fujitani eloquently argues, one type of mnemonic site used to create memory and ideology is ritual.[31] As an example of this ritualistic usage Matsuda Yoshifumi, Japanese Ambassador to the Philippines recently made the (ritualistic) pronouncement about Japanese being a peace-loving people to a crowd of 5,000.[32] As Fujitani points out, such pronouncements reflect both the desire to impart a particular image to others and to convince one's self of it as well.[33] The incorporation of the concept of peace and harmony into the information-society discourse is an intelligent way to sell the idea of informatization to a public who thus far has been reluctant to become mass consumers of information-sector products.

Promotion of Japanese Culture

Elements of the Japanese government, such as the Ministry of Education, have actively participated for some time in what can justifiably be called public relations campaigns by promoting to the world certain images of Japan and the Japanese. The insignificant costs of translating and publishing classic *nihonjinron* literature such as Watsuji Tetsuro's *Fudo* (1935) and distributing it throughout the world serve as one example.[34] The monumental costs of the Japan Exchange and Teaching Program(me) is yet another. Public relations endeavors like these are not at all uncommon, so in the age of the Internet it seems only appropriate that a private organization with the objective of providing to the world, "quality information about Japan and its global relations,"[35] receive state funds, even if they are funds which come from project fees billed to government agencies.[36]

Although the state's said objective is to make the understanding of Japanese culture by non-Japanese an integral theme of the information-society, the real purpose seems more narcissistic. MPT writes that "it is important for Japan to ensure that its ideas and their cultural contexts are fully and clearly communicated to foreign observers."[37] Much like Nakasone's National Museum of Ethnology and the Nichibunken,[38] the concept behind making Japan's culture understood by non-Japanese is grounded in the new 'liberal nationalism' that came to be a national ideology during the Nakasone administration.[39]

If *kokusaika* (国際化), or internationalization, is an attempt by Japanese to create a new, non-Western discourse with their own agenda in a post-modern world, as James Fujii argues,[40] then the call by the state to teach the world about Japan is an appeal to the growing sense among Japanese that they now have something worth showing the world. That 'something' is the unique, essentialized characteristics of the Japanese. It is reflected in their culture, and it is something for which they have pride. With the din of the *kokusaika* chant always in the background it is not surprising, then, that the state would justify informatization by saying that it will be a crucial vehicle in teaching the world about Japanese culture. With the flourishing of *nihonjinron*, particularly in the previous decade, and such unabashed public supporters of Japanese culturalist views as Nakasone and their relationships with informatization agents like Kumon, it also comes as no surprise to find that a state-sponsored, agent-created justification like the promotion of Japanese culture is an important theme of the information-society.

Theories of the Development of the Information-society

Some significant theories of the development of the information-society have been created which help to legitimize informatization. Recently there has been Kumon Shumpei to advance the theories of informatization. If community, intellectual creativity, ecology, peace and harmony, and promotion of Japanese culture are the themes of the information-society, then 'co-emulation' is one of the theories behind it. Like the themes of the information-society, Kumon's explanation of how this will develop is founded upon culturalist ideas. Because co-emulation is increasingly used to justify Japan's informatization it is important to understand how it is used to further sell the idea of an information-society to the public at large.

Kumon says that the information-society is arising in the current 'informatization phase' of the development of modern society. The paradigm of this society is the 'wisdom-game', not the 'wealth-game' of the 'industrial phase' or the 'prestige-game' of the 'militarization phase' of modern society.[41]

To substantiate the argument that the information-society will place an emphasis upon themes discussed earlier—community, intellectual creativity, ecology, peace and harmony, and international understanding of Japanese culture—the theory of co-emulation postulates a new paradigm for society. The theory says that as actors use persuasion and influence to compete in the wisdom game, they will learn from each other, continually bettering themselves by emulating the positive attributes of their competitors and forgetting any attributes that do not advance their goal of self-betterment. This new paradigm for society is exemplified by the institutions called 'intelprises' (coined from intelligent enterprises, and is essentially a think-tank/research center.) Intelprises compete in a global social system "in generating and spreading valuable information and knowledge with the aim of thereby enhancing their own wisdom."[42] Intelprises compete in this 'wisdom game' by using persuasion and inducement. This system sits in contrast to two previous paradigms, paradigms exemplified by the actors of sovereign states during Kumon's period of militarization (16-17th centuries), and industrial enterprises during the period of industrialization (18-19th centuries). The argument explains that sovereign states competed in the 'prestige game' by means of threat and coercion between 'nations,' and industrial enterprises have been competing in the 'wealth game' in the arena of the world market by using the tools of trade and exploitation. The new competitors will be 'intelprises' who compete through persuasion and inducement inside of a global network system. In this theory of the development of social systems, there is clearly a judgement being made that favors the systems as they advance in time. The paradigm of threat and coercion sits at the bottom of this evolutionary scale, and while the patterns of trade and exploitation reflect more civilized societies, it is the methods of persuasion and inducement that the most civilized actors of tomorrow will engage in when they compete in the innocuous 'wisdom game.' The progressively higher valuations of these paradigms is important to note because the theorizing implicitly places Japan as next torch-bearer leading civilization to a new plateau, thanks to the inherent qualities of Japanese culture.

The argument begins by setting up a comparison between Japan and the West using the individualism/contextualism dichotomy. This then develops into the 'Japanese society as an *Ie* society' argument. Next, the argument says that, "Japanese society itself [developed into] a gigantic network in which the mass media function as a nervous system."[43]

Both the logic and the conclusion are reflected in the section "the networks of Japanese society" in Kumon's most recent book Jōhō Bunmei ron (情報文明論), *Treatise on the Information Civilization*. The reader is lead to infer that Japanese culture has naturally, if unknowingly, placed Japan in the position of becoming the logical model for the next phase of human social development: "Japanese society is very much oriented in a manner that closely reflects the networks we see emerging with the information age."[44] In other words, Kumon's theory of co-emulation, supposedly a paradigm for informaticized societies, is really an iteration on how an information-society is truly a natural society for the Japanese and a model for the world. This theory legitimizes the state's program to informaticize because the state says that Japan will become a *jōhō shakai*. Co-emulation serves not only as a theory to explain the patterns of an emerging society, but it justifies the more important reason of why the Japanese must informaticize. It places Japan at the center of this new societal system where it is to be a model for other nations. In effect, Kumon's theory of co-emulation is really a theory of emulation; much in the same way that others have advocated the exportation of the 'superior' Japanese management systems world-wide, this theory advocates the export of the superior characteristics of the Japanese society.

Conclusion

Will informatization bring about a more intellectually creative society, increased community, reduction of environmental problems, harmony among people? For that matter, will it bring about democracy, the removal of class divisions, equality, individualism, free expression, decentralization of government or increased political participation, all of which are themes found in the information-age rhetoric employed in the informatization-speak of many other nations? There are serious reasons to doubt the effectiveness of informatization in bringing about these ideals, but there are already many good works which examine this topic by authors such as Phil Bereano, Langdon Winner and Tessa Morris-Suzuki.

In this paper, however, my goal was only to show that the Japanese state is not intent on changing the structure of Japanese society, only on developing the information-sector of the economy and enhance its own power. This is despite the strong rhetoric about creating a new state paradigm, one which focuses upon the quality of life, not the quantity of consumption. The value of the emerging information industries gives the state legitimate reason to focus upon the economic goal, but this is not what the state exhorts. For reasons such as sensitivity to images of being "little Sony salesmen" and a declining public interest in increasing the nation's economic prowess alone, the Japanese have become less and less interested in embarking on massive national efforts in the name of the economy. The state, therefore, has had to make informatization more palatable to the public, whom the state urgently needs to play the role of excited consumer that it has, in the past, done so well. To sell informatization to the would-be consumers of Japan the state has seized upon the discourse of *jōhō shakai*, the information-society, as developed by private writers and thinkers. Through the ink of their pens, in their interviews and with their authority in the intellectual realm, *jōhō shakai* has come to mean a structure of society in which people are intellectually creative, have regained a sense of community, are living in harmony both with others and the environment, and are proud to be Japanese (though this identity of being Japanese also involves being 'internationalized.'). These particular themes have been chosen—while other common themes have been ignored—because they have particular appeal to Japanese for they reaffirm strongly held ideas of what it means to be Japanese. The beauty of using these themes is not in the veracity—the information-society is less than likely to bring about any one of these—rather, the beauty lies in the narcissistic and self-serving purpose of telling the Japanese to buy the information-society for it means being Japanese. The idea of 'co-emulation', a recently developed theory explaining the creation and workings of the information-society, serves the same purpose. It rationalizes why Japan is expected to lead the world in the movement towards an information-society, thereby further legitimating the process of informatization. All of this, then, explains why the state has worked intimately with thinkers such as Kumon. They have provided both useful ideas by which to define *jōhō shakai* and legitimacy in promoting informatization. But this discourse has not translated into policy. That is because in the end, the state's narrow economic focus has not changed in the last 50 years. It is still guiding the nation down the path of economic growth while vying for positions of power within the state political-economic structure. Only now, in an era where the economy is shifting from industrial to informational, the state is clothing its economic objective and grasp at power in disingenuous rhetoric about creating a welfare society—the information-society.

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[1] MPT, "For Achieving Globalization of an 'Intellectually Creative Society'" section 1.g. Archived at

http://www.mpt.go.jp/Report/Interim_Report/section1.html

[2] A scholarship program is being established for this purpose by MITI's Machinery and Information Industry Bureau. Telecom Tribune, "MITI Helps Prepare for Multimedia Era through Promotion of Visual

Data" Vol.9, No. 1, March 1994.

[3] Kuwata Hajime, Director of Information Services Industry Division of the Machine and Information Industries Bureau. *The Telecom Tribune*, "Japan's Software Engineers need to Be More Responsive to Changing Market" Vol. 9, No. 9, November 1994.

[4] Kuwata Hajime, Director of Information Services Industry Division of the Machine and Information Industries Bureau. *The Telecom Tribune*, "Japan's Software Engineers need to Be More Responsive to

Changing Market" Vol. 9, No. 9, November 1994.

[5] Morris-Suzuki, Tessa Beyond Computopia London: Kegan Paul Internation, Ltd. 1988.

[6] MPT, "Communications in Japan 1994, Summary" 1994, archived at http://www.mpt.go.jp/White-Paper/CommunicationsInJapan1994/ Part 1.II.2.C Filled with various statistics.

[7] MITI, MITI Program for Advanced Information Infrastructure, May

1994, archived at http://www.glocom.ac.jp/NEWS/MITI-doc.html

[8] Nihon Keizai shimbun "Nihonngata Shihon Shugi no shōrai" (The

Future of Japanese-style Capitalism), July 28, 1993.

[9] Johnson, Chalmers MITI and the Economic Miracle: The Growth of Industrial Policy, 1925-1975 Stanford: Stanford University Press, 1982

[10] Pyle p. 85-105. This is also discussed in an unpublished paper by James A. Fujii "Culture, Political Economy and Japan's Discourse of Internationalization" University of California, Irvine.

[11] Inoguchi Takashi, "Japan's Response to the Gulf Crisis: An Analytic Overview" *Journal of Japan Studies*, Vol 17. No. 2.

[12] Think back, for example, to Candidate Bill Clinton's answer to the question about the most pressing issue in America: It's the economy, stupid.

[13] Reuters reported on April 28th, 1995, Japan's yearly average unemployment rate reached a new record, 2.95.

[14] According to *Kokuminsei no kenkyu dai 9 kai Zenkoku chosa* put out by the Institute of Statistical Mathematics, the 52% of the people surveyed who thought that standard of living in Japan was fairly good or very good in 1973 increased to 74%. p.96. Concerning the question about satisfaction with society, only 26% of respondents replied that they were fairly or very satisfied in 1973. Twenty years later the percentage was 50%. The numbers of purely unsatisfied people decreased from 30% to 10%. p. 37.

[15] MPT, "For Achieving Globalization of an 'Intellectually Creative Society'" section 1.c.

[16] Kumon, Shumpei. "Japan and the United States: Creativity and Constructive Co-emulation During the Great Transformation" The paper was submitted to the Multimedia Round table held in Los Angeles in April 1991. Section 4.

[17] The first is the title of the MPT Interim Report, January 23, 1995. The second is the title of an article by Kumon Shumpei of the International University of Japan, the ideas of which are examined later on. In a personal letter from Kumon, he acknowledges the influence of Masuda Yoneji, among others, on his thinking.

[18] Social Policy Bureau, The Information Society and human Life, p. 60-61.

[19] See the Social Policy Bureau's The Information Society and Human Life, section 5.

[20] Tōkei Sūri Kenkyūjo (The Institute of Statistical Mathematics) *Kokuminsei no kenkyu dai 9 kai Zenkoku chosa: 1993 nen zenkoku chōsa* (A Study of the Japanese National Character: the 9th Nationwide Survey), Tokyo: Tōkei Sūri Kenkyūjo, 1994.

[21] Hamaguchi Esyun, "A Contextual Model of the Japanese: toward a Methodological Innovation in Japan Studies", *Journal of Japanese studies*, Vol. 11. No. 2, p. 302-303.

[22] See, for example, Kumon's "Some Principles governing the Thought and Behavior of Japanists (Contextualists)" *Journal of Japan Studies*, p. 5-28 Vol. 8, No. 1.

[23] Ibid, p. 17.

[24] Quote taken from Morris-Suzuki, p. 60. Original by Computerisation Committee, The Plan for an Information society: a National Goal Toward Year 2000, p. 10. Italics are original.

[25] Telecom Tribune, "Building the Information Communications Infrastructure for the Multimedia Age", Vol 9, No. 3, May 1994. Archived at http://www.glocom.ac.jp/tel-trib

[26] See, for example, MPT, Telecommunications Council Report Sections 2.1.c, 1.2.c and 2.1.6.

[27] MPT, Press Release 22 September 1994, "Telecommunications Summit Issues Kyoto Declaration to Urge Global Cooperation", archived at http://www.mpt.go.jp/ITU/0927-Press_Rel_22_sep.html

[28] MPT, "For Achieving Globalization of an 'Intellectually Creative Society'" section 1.c.

[29] comment found at http://jw.nttam.com/COMMENTS/archives/archive3.html, written on 03/18/95 by Kobo Inamura (HEG03577@pcvan.or.jp)

[30] Takigawa Hirō Nihonjin nitotte. Wa to Wa nanika. Saitama: Shogaku Kenkyū Sha. 1987. p. 90. Translated by Kristin Peterson.

[31] Fujitani, Takashi "Remembering, Forgetting, Inventing" Befu, Harumi, ed. *Cultural Nationalism in East Asia* Berkeley: UC Press, 1993, p. 87-97. I use ritual here in a wider sense than Fujitani's use, but believe it is applicable. Where Fujitani's 'ritual' is more of an event repeated at regular intervals and/or has official or religious overtones, such as actions during weddings, inaugurations or burials, my use of ritual also applies to the repeated use of phrases under certain conditions. The Ambassador's speech to commemorate the 50th anniversary of the end of the Pacific war is an example of this, as is the language used:"peace-loving people." This phrase is also used ritualistically in the talk of war among many Japanese in my own experience.

[32] Associated Press, 27 April 1995.

[33] Fujitani, Takashi "Inventing Forgetting, Remembering" p. 79.

[34] This book was translated in 1961 by Geoffrey Bownas under a grant by the Ministry of Education and then published by the Printing Bureau of the Japanese Government. This is just one such example.

[35] The Inforum Project. See Http://www.glocom.ac.jp. Certainly it has, served as an important source of information for this paper. My gratitude not withstanding, such projects are not above criticism. In the case of GLOCOM, the information originating from its archives is not terribly diverse in its content nor its perspective, with an obvious slant in favor of MITI and MPT despite the extensive criticism they receive in the printed press for impeding Japan's informatization. However, this World Wide Web site is only recently formed and probably still needs to find its footing.

[36] This is Global Communications, a division of Tokyo International University, a private institution.

[37] MPT, "Telecommunications Council Report: Reforms toward the Intellectually Creative Society in the 21st Century" section 1.2.b.

[38] The museum holds comparative exhibits between Japanese and non-Japanese cultural objects. According to James Fujii, these exhibits have the dual effect of patronizing the object (the foreign culture) and elevating the subject (Japanese culture). p. 18. The Nichibunken is considered by many to be another Nakasone-initiated monument to Japanese culture.

[39] Pyle, pp. 94-101.

[40] Fujii.

[41] For an in depth discussion on Kumon's ideas of prestige, wealth and knowledge, see Kumon, Shumpei and Akihiko Tanaka "From Prestige to Wealth to Knowledge" Inoguchi Takashi and Daniel I. Okimoto, ed., The Political Economy of Japan: Volume 2. The Changing International Context Stanford: Stanford University Press, pp. 64-82, 1988.

[42] Kumon Shumpei, "Japan and the United States: Creativity and Constructive Co-emulation During the Great Transformation", section 2.

[43] Ibid., section 3.

[44] Aizu Izumi and Kumon Shumpei, "Co-emulation: The Case for a Global hypernetwork Society", section 41. "'Japanese' ways to contribute to global problems". Aizu Izumi is another important agent. He holds the position as Project Director for GLOCOM's Institute for a Hypernetwork Society and writes frequently on issues pertaining to both human and machine 'networks', often conflating the two. See InterCommunication, Summer 1993, 5, p. 66-67. He sometimes appears in *Wired*, as well.

Aizu, Izumi and Kumon Shumpei, "Co-emulation: The Case for a Global hypernetwork Society"Archived at http://www.glocom.ac.jp/Publications/co-emulation.html, Date unknown

Keizai Shingikai Jōhō Kenkyū Inkai *Nihon no Jōhōka Shakai: sono Kadai to Bijon* (Japan's Information-society: its Themes and Visions). Tokyo: Printing Bureau, Japanese Government, 1969

Hayashi, Yūjirō *Jōhōka Shakai: Hādo na Shakai Kara Sofuto na Shakai e* (The Information-society: From Hard to Soft Society). Tokyo: Kodansha, 1969

Hayashi, Yūjirō Nihongo ha Kokusaigo ni naruka? (Will Japanese Become an International Language?), Tokyo: TBS Buritanika, 1989

Befu, Harumi, ed. Cultural Nationalism in East Asia Berkeley: UC Press, 1993

Berano, Philip L, ed. Technology as a Social and Political Phenomenon New York : Wiley, 1976

Carnoy, Martin, et al. The New Global Economy in the Information Age University Park: Pennsylvaina State U. Press, 1993

European Commission, "Info2000 Programme Proposal" archived at http://www.echo.lu/impact/en/in2000-1.html, 1995

European Commision, "The Information Market Policy Actions (IMPACT) Programme", archived at http://www.echo.lu/impact/en/impacthome.html

Gilpin, Robert The Political Economy of International Relations Princeton: Princeton University Press, 1987

Gyōsei Jōhō shisutemu Kakushōchō Renraku Kaigi Ryōshō Gyōsei Jōhōka no Keikakuteki suishin nituite (On Planning to Digitalize Administrative Work), Archived at ftp://ftp.glocom.ac.jp/pub/misc/GovInfoPlan1.j.txt, July 1994

Hamaguchi, Esyun, "A Contextual Model of the Japanese: toward a Methodological Innovation in Japan Studies" *Journal of Japanese Studies* Vol. 11, No. 2.

Hayashi Yūjirō, Suzuki Takao, Antonio Arufonso hoka Nihongo wa kokusaigo ni naru ka / Nihon Mirai Gakkai hen Tokyo: TBS Buritanika, 1989

Inoguchi Takashi, Journal of Japan Studies,, "Japan's Response to the Gulf Crisis: An Analytic Overview" Vol. 17, No. 2

Inoguchi Takashi and Daniel I. Okimoto, ed., The Political Economy of Japan: Volume 2 The Changing International Context Stanford: Stanford University Press, 1988

Inter-Ministerial Council of Administrative Information Systems "Action Programmes on Common Issues for Adminstrative Informatization" Archived at ftp://ftp.glocom.ac.jp/pub/GLOCOM/project/INFORUM/commonplan-e.txt, March 1995

Japan Computer Usage Development Institute, Computerisation Committee. 1973 The Plan for an Information society: a Natinal Goal Toward Year 2000. Publisher not known.

Johnson, Chalmers MITI and the Economic Miracle: The Growth of Industrial Policy, 1925-1975 Stanford: Stanford University Press, 1982

Kumon, Shumpei, "Information and Internationalization"*Japan Review of International Affairs*, Winter 1995, Vol. 9 No. 1. Tokyo: Japan Institute of International Affairs

Kumon, Shumpei, "Some Principles governing the Thought and Behavior of Japanists (Contextualists)" *Journal of Japan Studies* Vol. 8, No. 1

Kumon, Shumpei Jōhō Bunmei ron (Treatise on the Information Civilization), Tokyo: NTT Publishing, 1994

Kumon, Shumpei and Henry Rosovsky, ed. The Polical Economy of Japan Volume 3: Cultural and Social Dynamics Stanford: Stanford University Press, 1992

Kumon, Shumpei. "Japan and the United States: Creativity and Constructive Co-emulation During the Great Transformation" The paper was submitted to the Multimedia Roundtable held in Los Angeles in April 1991.

Masuda, Yoneji The Information Society as Post-Industrial Society Bethesda: World Future Society, 1969

Masuda, Yoneji Managing in the Information Society: Releasing Synergy Japanese Style Cambridge: Basil Blackwell, 1990

Masuda, Yoneji and Masamura, Kimihiro Kōdo Jōhō Shakai ha Ningen wo Dō Kaeruka? (How Will the Advanced Information-society Change Humanity?). Tokyo: TBS Buritanika, 1969

Murakami, Yasusuke "Ie Society as a Pattern of Civilization" *Journal of Japan Studies*, Vol 10. No. 2

McLuhan, Marshall and Bruce R Powers The Global Village :Ttransformations in World Llife and Media in the 21st Century New York: Oxford University Press, 1989

MITI Program for Advanced Information Infrastructure Archived at http://www.glocom.ac.jp/NEWS/MITI-doc.html, May 1994

Morris-Suzuki, Tessa Beyond Computopia London: Kegan Paul Internation, Ltd, 1988

MPT "Communications in Japan 1994, Summary" Archived at http://www.mpt.go.jp/White-Paper/CommunicationsInJapan1994/, 1994

MPT "For Achieving Globalization of an 'Intellectually Creative Society'" Archived at http://www.mpt.go.jp/Report/Interim_Report/

MPT "Telecommunications Council Report: Reforms toward [sic] the Intellectually Creative Society of the 21st Centruy" Archived at http://www.mpt.go.jp/Report/Report1993No5/, 1993

NTT, *InterCommunication*, Summer 1993, No. 5. Tokyo: NTT Publishing

President's Office "Agenda for Action" Archived at http://sunsite.unc.edu/nii/NII-Agenda-for-Action.html, No Date

President's Office "Ihe Adiminstration's Agenda for Action" version 1.0, archived at http://sunsite.unc.edu/nii/NII-Agenda_for_Action.html, No date

Pyle, Kenneth B. The Japanese Question: Power and Purpose in a New Era Washington, D.C.: AEI Press, 1992

Social Policy Council Economic Planning Agency of Japanese Government, *The Information Society and Human Life: The Outlook for the People's Lives in the Information Society* Tokyo: Social Policy Committee Bureau, Economic Planning Agency of the Japanese Government, March 31st, 1983

Takigiwa Hirō Nihonjin nitotte, Wa to Wa nanika Saitama: Shogaku Kenkyū Sha, 1987

Telecom Tribune. Archived at http://www.glocom.ac.jp/tel-trib

Toffler, Alvin The Third Wave New York: Morrow, 1980

Tōkei Sūri Kenkyūjo (The Institute of Statistical Mathematics) *Kokuminsei no kenkyu dai 9 kai Zenkoku chosa: 1993 nen zenkoku chōsa* (A Study of the Japanese National Character: the 9th Nationwide Survey), Tokyo: Tōkei Sūri Kenkyūjo, 1994

Ueyama Shunpei, Uemhara Takeshi, and Yano Toru, *Japan Echo*, "The Imperial Institution in Japanese History" 16, Spring 1989

Umeso Tadao, Harumi Befu and Josef Kreiner, ed. *Japanese Civiliation in the Modern World: Life and Society*., no. 16. Senri Ethnological Studies. Osaka: National Museum of Ethnology, 1984

Watsuji, Tetsuro. Trans. Geoffrey Bownas A Climate: A Philosophical Study Tokyo: Printing Bureau, Japanese Government, 1961

Winner, Langdon The Whale and the Reactor Chicago: University of Chicago Press, 1986

ADVANCED NETWORKS = INFORMATION, EDUCATION, ECONOMIC DEVELOPMENT, SOCIAL DEVELOPMENT

David R. Block
ARK Telecommunications, Inc.
Santa Maria, California, U.S.A.

ABSTRACT

This paper focuses on the role of telecommunications in the Pacific region and the need for countries to set an Information Infrastructure agenda. The paper purports that telecommunications cannot be divorced from the development needs of countries; nor can they be decoupled from the role they should play in the social, economic and political development of the pacific region. The paper concludes with a preview of telecommunications technologies in the remainder of this decade/century and renders predictions on how satellite communications may be a way to best address the telecommunication needs.

INTRODUCTION

Figure 1 shows Paul, who works in the offices of KEMTEC, a domestic supplier of agricultural farming equipment. He is calling the local Bank's loan officer Mary to confirm a business transaction. They are using clear digital satellite technology. When they are finished, the network capacity they are using will be released for use by other people. Sharing network capacity helps reduce everyone's costs.

In the same network, maybe even at the same time, several offices of the Department of Government Statistics (or the Ministry Of Industry) are communicating with each other. See Figure 2. Computers are exchanging information and people are using telephones and faxes. Maybe new policies are being drafted. Maybe forms and administrative paperwork is being processed. The total effect is that people are doing their work more efficiently and quickly. This picture represents two positive achievements:

(1) The operating costs of the government are being reduced through savings and increased productivity; and (2) The services to the public are improved; "come back next week" is now replaced with "your application will be ready for you tomorrow morning".

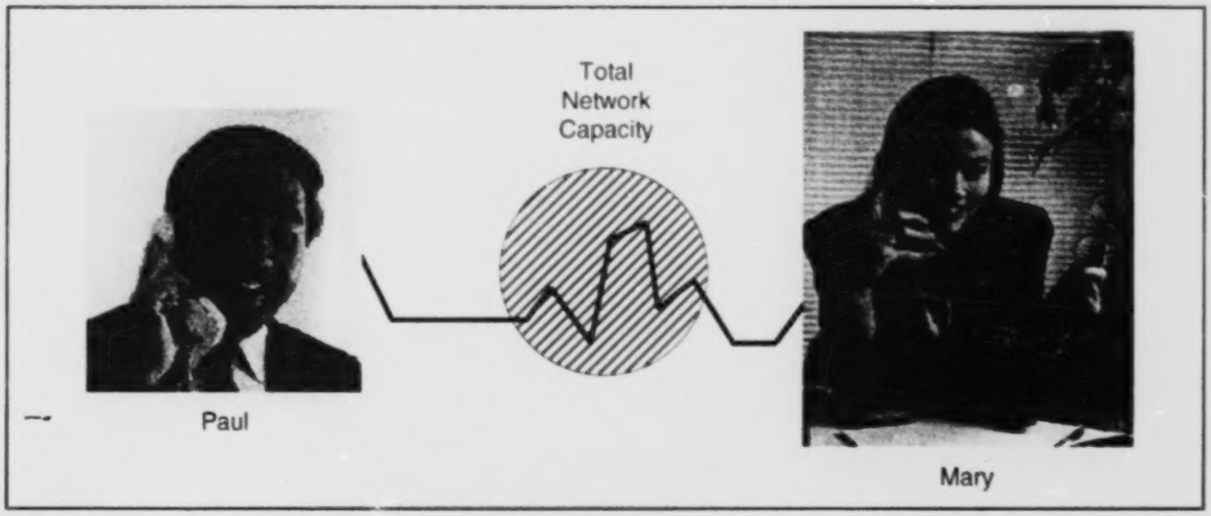

FIGURE 1. TELEPHONE SERVICES USING THE ACT-ONE

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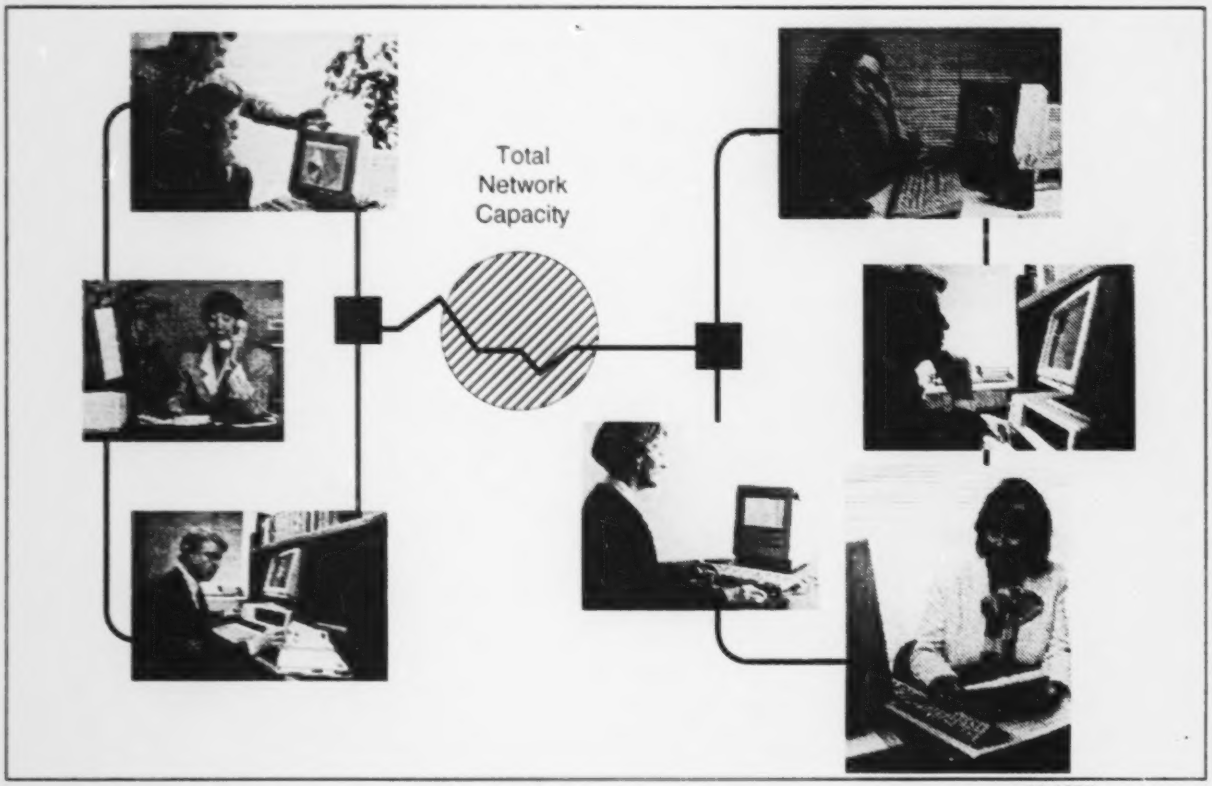

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FIGURE 2. DATA SERVICES USING THE ACT-ONE

In Figure 3 we see government offices all over the country communicating and discussing many aspects of their daily work. Or maybe the picture is of branches of a Bank discussing loan rates and deposit records. Or maybe this is a private network of a foreign corporation with several offices throughout your country or region.

In all of these images two things must be recognized: (1) Information is needed everywhere, not just in the major cities; and (2) The **types** of information are so different, and have very different communications characteristics. Like your postal service, information arrive in many sizes and weights; some urgent, others not. Telephone services, faxes, computer files, videoconferencing, electronic mail...all require different environments to transport them from source to —> destination (i.e., multimedia). This is not some futuristic picture we will all reach in the next century. This is what we should be putting in place today. Why? Because *the future wealth of nations will be determined by how they position themselves to take advantage of* ***information*** *in the global economy*. And as we shall see, this global economy is dominated by....information and timing!

THE ECONOMIC AND SOCIAL AGENDA

Our efforts to define and implement economic and social agendas are driven by our desire to eliminate historical stereotyping of nations: 1st world vs. 3rd world; north vs. south; developed vs. developing or under-developed. ARK Telecom has always believed that a country's economic and social agenda should be derived from three levels of strategic planning....or mini-agendas:

i) A **REGIONAL** agenda: that defines how each of our countries will interact economically and commercially with its neighbors. What common good will we reap by grouping ourselves as one? The European Community, NAFTA and other trading blocs being formed represent a regional agenda.

ii) A **DOMESTIC** agenda: that defines the socio-economic programs that will improve the standard of living of your people, and allow them to participate in (and benefit from) these programs.

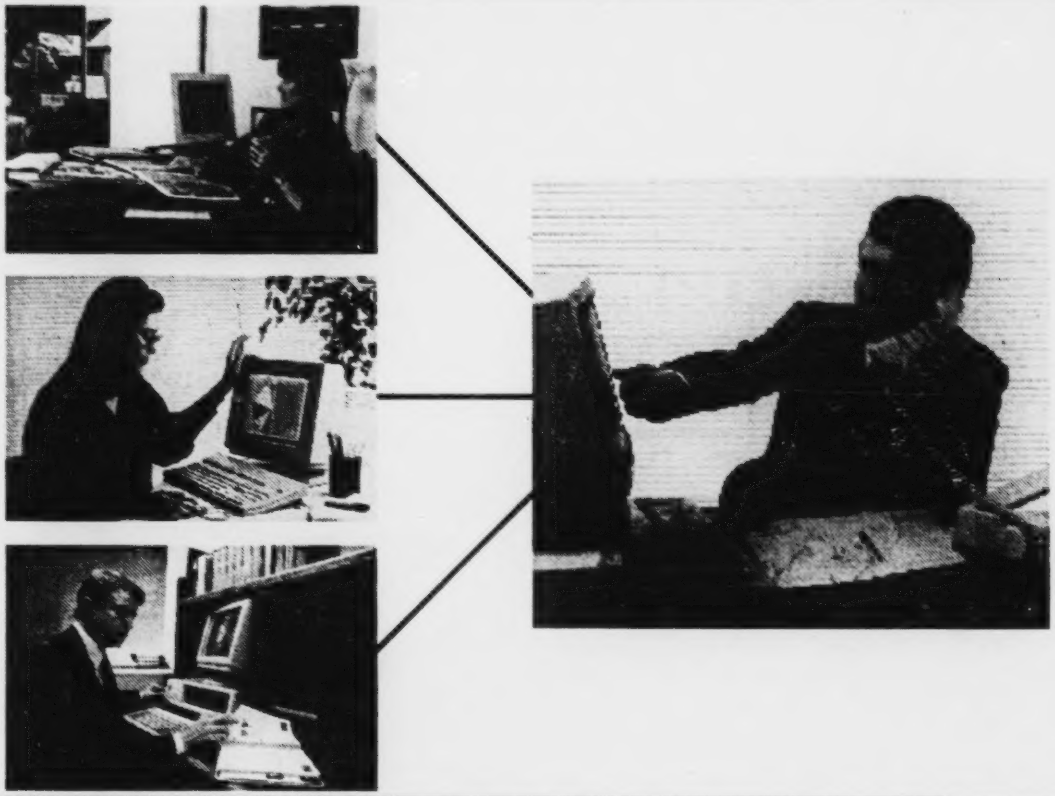

FIGURE 3. BUSINESS VIDEO SERVICES USING THE ACT-ONE

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iii) **A CORPORATE** agenda: that encourages the private sector (foreign & domestic) to view your country as "business friendly", so jobs are created, services are generated and standards of living are elevated.

In all three agendas, we will see that a strong information infrastructure is no longer "preferable", but vital.

At the regional level, it matters not whether you are rich in natural resources (witness Japan and South Korea) or in heavy industry (witness Hong Kong & Singapore), but on whether your country is a "player" in regional economics:

- Do you produce and export the most automobiles? — Japan
- Do you house major financial, banking and shipping services? — Singapore, Hong Kong
- Are you a major producer of oil and natural gas in your region? — Indonesia
- Do you produce and export agricultural products?

If your country cannot find ways to "participate", it may very well still become a member in regional markets and trading blocs — but as a dependent consumer (Figure 4). The terms "global economy" and "global village" should suggest to you that the need for advanced telecommunications infrastructure is no longer a matter of IF or WHEN to implement it — but HOW.

The domestic agenda for a telecommunication infrastructure has its own exciting opportunities. Where do we start? Figure 5 illustrates only some of the many government applications that serve the domestic agenda. Although not exclusively, the domestic agenda typically represents the public sector. Contrary to popular belief, domestic agendas need not be viewed as non-profit altruistic efforts by your country's government. Advanced social services such as medicine and education yield economic returns for larger than their financial costs. Telecommunications technologies are poised (as never before) to accelerate such benefits.

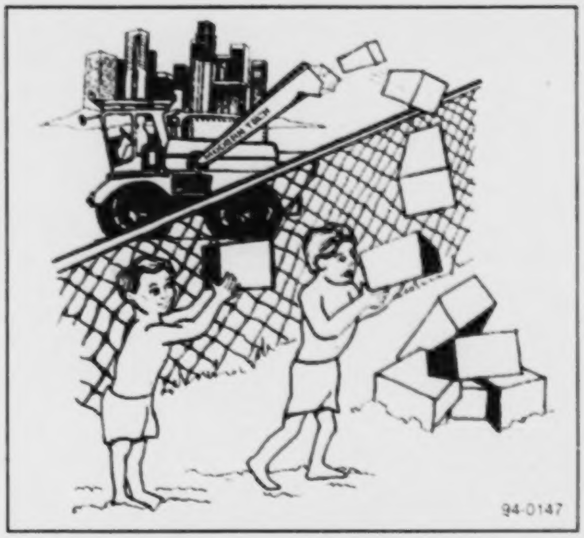

FIGURE 4. CONSUMER MEMBERS OF A REGIONAL TRADING BLOC

The corporate agenda focuses on the private sector — both domestic and foreign. Figure 6 presents some industries in the private sector. Figure 7 depicts others. Throughout these industries the exchange of information is not merely convenient, but vital to the workers. Despite this, the private sector often views telecommunications infrastructure as a social element of the domestic agenda. Often as a utility (e.g., PTT). Only when the PTT cannot satisfy demand and is deregulated, will the private sector enter this arena. Even then, the private sector initially deploys private networks and competes with the monopoly public sector PTTs for the higher revenue services.

Here, we must stop to reflect on the complex dependencies between the three agendas. The struggle between monopoly PTTs and private telecom ventures very often delays the deployment of infrastructure by decades. This in turn creates a weak business environment — hardly a setting that attracts foreign capital and businesses. Who loses? The job market loses, the private sector's productivity is stifled and the social services such as medicine and education fall further behind. Is the regional agenda spared any fallout? No. A domestic economy that is not harnessing advanced technologies hardly reflects a strong regional player.

THE ROLE OF SATELLITE TELECOMMUNICATIONS

By now it has become obvious that the exchange and distribution of information pervade all three agendas... and all elements of this paper's title: education, economic development and social development. Telecommunications is not divorced from the development needs of countries. Nor can it abdicate the role it should play in the social, economic and political lives of countries in this region. How do governments weave the rapid advances in

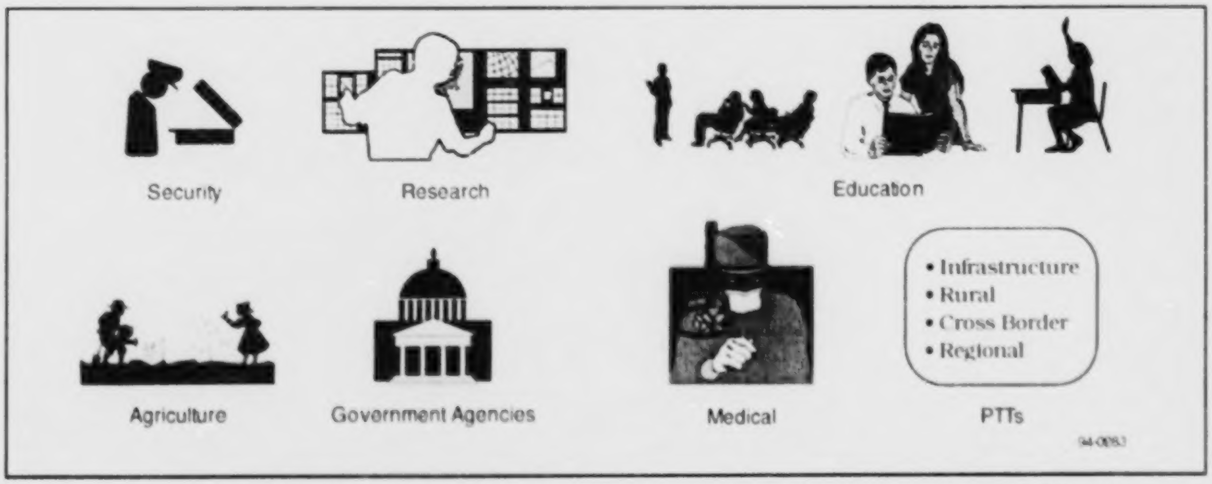

FIGURE 5. SOME GOVERNMENT APPLICATIONS THAT NEED ADVANCED TELECOM SERVICES

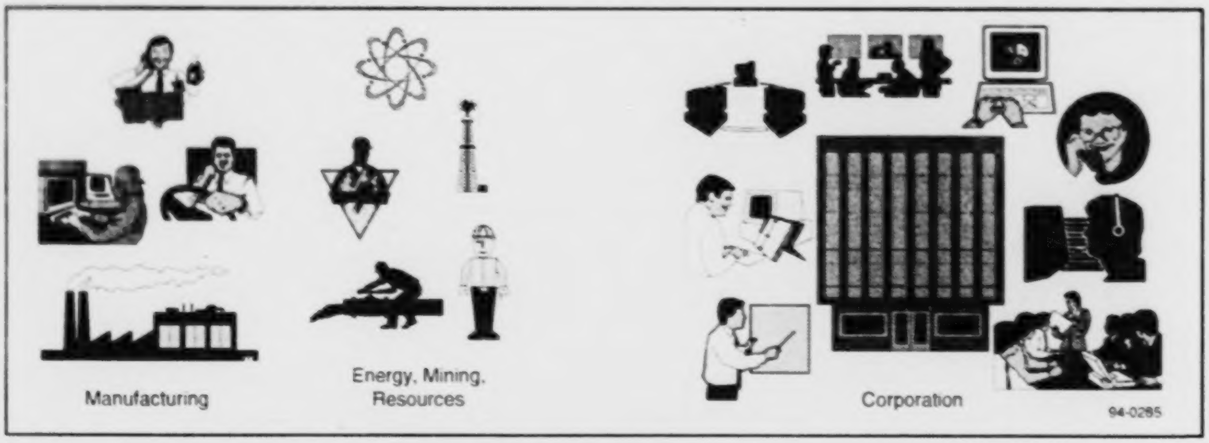
Manufacturing
Energy, Mining,
Resources
Corporation
94-0265

FIGURE 6. IMAGES OF THE PRIVATE SECTOR IN MOTION

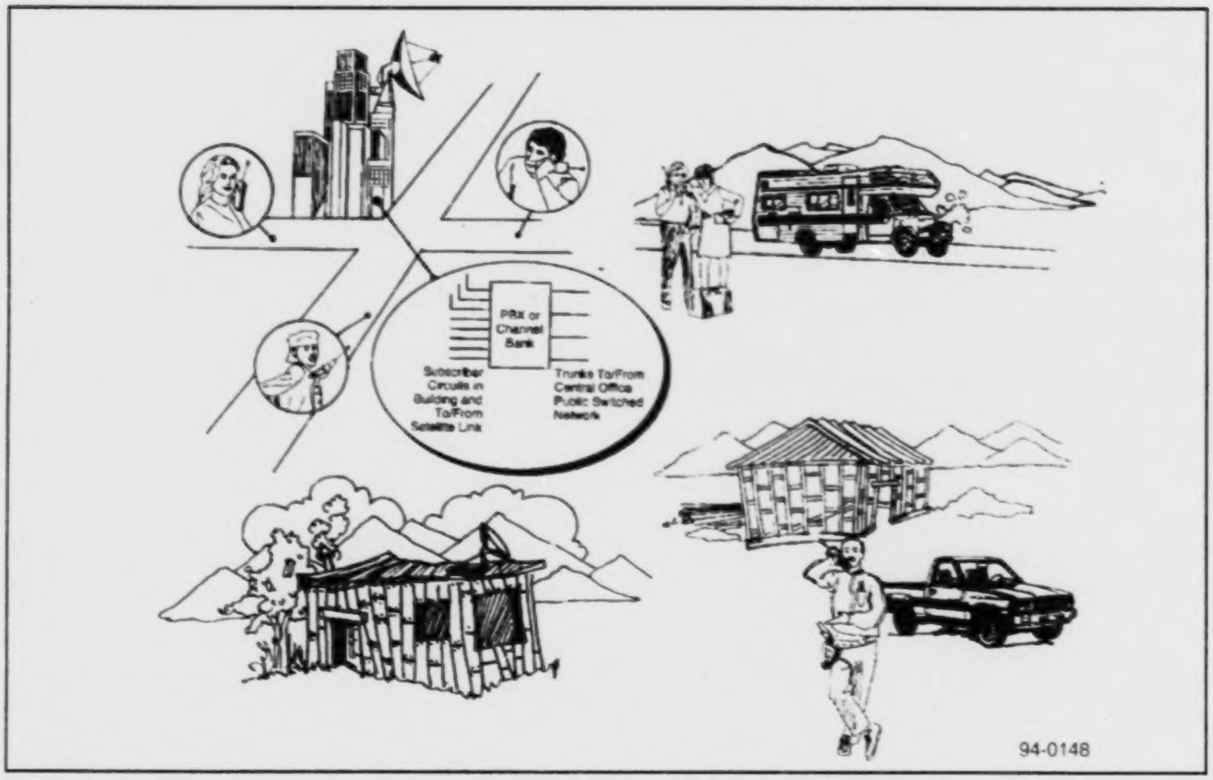
PBX or
Channel
Bank
Subscriber
Circuits in
Building and
To/From
Satellite Link
Trunks To/From
Central Office
Public Switched
Network
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FIGURE 7. MORE IMAGES OF THE PRIVATE SECTOR'S NEED FOR TELECOM

telecommunication technologies into their five-year plans and agendas? How do they avoid becoming a target for the latest "fashion boutique technology" imported from outside the region? By focusing on the definition and implementation of their three agendas.

In principle the use of satellite to deploy networks satisfies several elements in all three agendas:

(1) Their ability to interconnect vast territories facilitates regional infrastructure and economic cooperation

(2) Their ability to be deployed rapidly and cheaply help domestic agendas cope with the scarcity of foreign exchange and rising budget deficits[1]. Time wasted lagging behind can be made up quickly.

(3) Their increasing flexibility assures corporate users that their investment today will not be rendered obsolete by their future needs.

Given these advantages, why are satellite networks not more dominant? The answer is simple, but not easy to solve. There are two reasons (i) they still only marginally satisfy point number (3) above (satellite networks are not as flexible as they should be); (ii) nor are they as easy to use: Our satcom industry has learned surprisingly little from the computer industry over the past 25 years. Let us examine these two problems closer.

(i) Flexibility: Most would agree that the popular satellite networking technologies today are SCPC-DAMA, TDMA and star-VSATs[2]. Yet each one of them alone suffers from limitations that prevent it from being a true multi-media platform:

- SCPC-DAMA: It cannot support wideband data and image applications. It is confined to very thin route telephone services and data services below 64 kbps. its centralized control suffers from bottleneck congestion and presents an unreliable (and dangerous) single-point of failure. So far it is relegated to rural and remote locations where, contrary to the theme of this paper, it is incorrectly assumed that advanced services are not important.
- TDMA: Most TDMA products today do not handle packetized data applications very efficiently. Given the explosion in InterNet usage, this is a fatal flaw. Its solution to centralized control is expensive: it uses two stations as reference stations for control. Because of architectural limitations, TDMA networks cannot grow beyond 50-64 locations. Larger TDMA networks exhibit sluggish performance and low efficiencies in using the satellite capacity. Broadcast services over TDMA are inefficient.
- Star-VSATs: They are primarily efficient for very low volume interactive computer applications (e.g., bank credit card verifications). They too suffer from vulnerable centralized control. All traffic (regardless of destination), must pass through a central station, giving rise to what the industry has labeled "double jeopardy": twice the delay in services and twice the cost of each circuit. This technology is even more limited than SCPC-DAMA in satisfying the emerging multi-media and ISDN applications. Valiant efforts to establish VSAT networks for telephone services or videoconferencing have proven to be expensive mistakes.

One must trace the historical originals and evolution of these technologies (some reaching back 50 years) to understand how they are what they are today.

(ii) Ease of Use: As long as satellite telecommunications continue to conjure up images of deep space, deeper mystery and complex electronics, it will not reach out to the people and entities who need it most. Today most of us would agree that the installation and operation of satellite networking equipment seems as complex as medical micro-surgery.

It is both these elements of satellite networking that we must attack... and remedy. To do so means we cannot keep polishing the obsolete architectures of old. Instead, we must develop new architectures and new concepts from the advances we have made in electronics, computers and software. Concepts that are derived from today's and tomorrow's requirements, not from theories dating back to the 1930s. ARK Telecom has dedicated itself and its research and development skills to such a goal. I say that, not because we wish to advertise our company at this forum. But because we see an opportunity for advanced satcom networks to assist countries and regions to accelerate the social and economic development agendas we spoke of; to leap across the economic divisions we described in this paper; and to harness technology for the development of its people, rather than worship technology in awe.

"Quick, low-cost, reliable and flexible". These are the watchwords for the satcom architectures of tomorrow.

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[1] Whereas deployment of extensive fiber optic cables and microwave radio networks can take years to complete, regional satellite networks are deployed in less than six months!

[2] See "FATMA... The New Generation VSAT", presented by ARK Telecom at ICT'95 in Indonesia.

Critical Obstacles to Telecommunications Development in Developing Countries

Ryota Ono
University of Hawaii at Manoa
Honolulu, Hawaii, USA
ryota@hawaii.edu

1. ABSTRACT

Why isn't the picture of telecommunications development in many developing countries promising, given that it is widely recognized that the telecommunications infrastructure is the essential infrastructure in the current and coming age? What are the obstacles that have prevented the development of the essential capabilities? In order to address the latter question, the current study solicited a variety of perspectives of telecommunications professionals from approximately 50 countries by using a two-rounds international questionnaire survey. One hundred twenty seven obstacles were identified across such categories as policy and regulation, planning and implementation, organization and administration, finance, technology, human resources, knowledge, politics, economy, and geography. The study presents and discusses key obstacles among the 127 obstacles.

2. INTRODUCTION

While we are in the process of building the Global Information Infrastructure (GII), we also need to be concerned with situations involving the telecommunications infrastructure build outs in developing countries. The Missing Link, which was the report of a study conducted by the Independent Commission for World Wide Telecommunications Development (called "The Maitland Commission") for the ITU, revealed that there was an immense gap in access and the extent of telecommunications service offerings between developed countries and developing countries. It stated:

> ...two-thirds of the world population have no access to telephone services....nearly three-quarters of the world's population live in countries with 10 telephones or fewer for every 100 people, and over half the world's population live in countries with less than one telephone for every 100 people. (Independent Commission for Worldwide Telecommunications Development [The Maitland Commission], 1984, pp. 13-15)

The Pacific Telecommunications Conference in 1994 addressed the status of telecommunications development in developing countries. At the conference, the Secretary-General of the ITU stated:

> At the end of 1992, almost 50 countries accounting for over half the world's population had a teledensity of less than 1....As long as half the world's population suffers from low levels of telecommunications development, the vision of a global electronic village remains a dream. (Tarjanne, 1994, p 9)

The Undersecretary of the Department of Transportation and Communications in the Philippines stated that the major problems still remained, such as access to telephone service, large unmet demand, unbalanced urban-rural distribution and poor quality of service (Lichauco, 1994). In recalling overall development during the last decade, Sir Donald Maitland (1984), who served as chair of the Maitland Commission, stated that the global picture of telecommunications development was not necessarily encouraging.

Why isn't the picture of telecommunications development in many developing countries promising, given that it is widely recognized that the telecommunications infrastructure is the essential infrastructure in the current and coming age? Something has prevented developing countries from improving their telecommunications capabilities. The key question is what are the obstacles that are preventing the development of these essential capabilities.

3. CURRENT KNOWLEDGE ABOUT OBSTACLES

The Maitland Commission (1984) analyzed several obstacles to closing the telecommunication development gap. They are summarized as follows:

1. Funding:
    a. Developing countries need more capital than they can raise themselves; and,

   - b. Hard currency necessary for purchasing telecommunications equipment abroad is scarce.
2. Priority of telecommunications:
   - a. Other sectors such as agriculture, health, education and roads get a higher priority in national budgets than telecommunications due to the lack of understanding of the catalytic role of telecommunications in development.
3. Imported equipment:
   - a. The design of imported equipment is less suited to the environments and needs of developing countries;
   - b. Manufacturers abroad stop producing old systems that are still widely used in developing countries, and as a result, developing countries are forced to replace their equipment; and,
   - c. Different types of equipment installed over a number of years lead to difficulties of training, compatibility and maintenance.
4. Service in remote areas:
   - a. Various geographical barriers to remote areas as well as lower monetary returns from those areas reduce the incentives to extend telecommunications services to those areas.

Wellenius (1989) argued that developing countries had three obstacles to overcome. The first obstacle is the scarcity of foreign exchange. The second one is the operating entities' inadequate internal organization and management. And the third obstacle is the insufficient autonomy of the operating entity from the government. The Secretary-General of the South Pacific Forum Secretariat expressed his concern that governments in many developing countries had been dependent on the telecommunications sector's cash flow for use in other sectors. He also stated that the capital investment in telecommunications was often linked to the next available aid package (Tabai, 1994, p. 43). Parker (1992) pointed out that power holders in government tended to oppose development of telecommunications fearing that the development would weaken their current power. He argued that existing economic and political power holders needed to be persuaded that the development of telecommunications could allow win-win propositions.

The ITU (1994a) discussed some of the most common obstacles to telecommunications development:

1. Lack of re-investment:
   - a. Whereas rapid telecommunications development was achieved in countries where at least 50 per cent of telecommunications revenues were reinvested, he level of reinvestment is still low in many other developing countries.
2. Poor quality of service:
   - a. Outdated equipment and inadequate maintenance result in poor quality of service, and as a result, this leads to the loss of revenues.
3. Foreign exchange scarcity:
   - a. Hard currency is limited due to high external debt and limited export earnings; and,
   - b. Foreign exchange through the international accounting rate system tends to be transferred to the central bank instead of being directly used for telecommunications development.
4. Investment inefficiencies:
   - a. In many developing countries, the cost of installing one telephone line is far beyond the widely used figure of around US $1,500;
   - b. Higher installation cost per line in rural areas hinders the extension of the network to those areas; and,
   - c. Such promising low cost technologies as cellular radio and VSAT (Very Small Aperture Terminal) suitable for rural areas tend to be provided primarily to urban areas.
5. Absence of universal access policy:
   - a. Many developing countries lack a universal access policy.
6. Inadequate private sector involvement:
   - a. Private sector involvement has not yet been adopted by many developing countries.
7. Insufficient regional cooperation:
   - a. Cooperation for regional links, pooled equipment purchases, shared training and technical specifications on equipment have rarely been fully exploited.
8. Organizational limitations:
   - a. Because telecommunications services are provided by monopoly government-run organizations in most developing countries, there are few incentives for better performance; and,
   - b. It is difficult to retain qualified staff due to low salaries.

In relation to item 8 above, former Deputy Director General of India's Department of Telecommunications comparatively analyzed a number of typical arguments for and against reform of telecommunications entities (Chowdary, 1992). He stated, "...most of these reforms are opposed by the government departments providing telecommunication services in many developing countries." Although this kind of issue is not often documented, it could be a hindrance to telecommunications development in developing countries.

While all the above obstacles seem to exist in developing countries, Hudson (1983) presented one obstacle attributed to developed countries. She pointed out that international development institutions charged with assisting developing countries had not well understood the role of telecommunications for developing countries. She argued that those institutions were inclined to regard telecommunications as an urban luxury and their loan requirements tended to ignore services in rural areas.

Reviewing the current knowledge about obstacles, the following questions emerge. Among those identified obstacles, which obstacles have a greater negative impact on the development of telecommunications? Are there any obstacles that have not yet been revealed? The study present here is aimed at answering these two important questions.

4. INTERNATIONAL TWO-ROUNDS SURVEY

In order to investigate the research questions in a comprehensive manner, a variety of perspectives of telecommunications practitioners was solicited by using a two-round iterative international survey. The survey method using questionnaires was used because it was necessary to get opinions of people who were geographically dispersed throughout the world. A first-round survey was designed to identify existing obstacles and a second-round survey was to assess how critical each of the obstacles was.

4.1 Survey Participants

As a convenient sample of highly qualified people, this study used the national delegates as well as representatives of international and regional organizations/agencies to the ITU World Telecommunication Development Conference that was held in Buenos Aires, Argentina, in March 1994. The purposes of the conference were:

1. to review the progress made in telecommunication development in the last decade;
2. to set the goals and objectives and to define and establish a common vision and strategies for achieving balanced telecommunication development by and beyond the end of the century; and,
3. to develop an action plan translating the goals and objectives agreed upon into a concrete work programs to be implemented over the next four years (ITU, 1994b, p 1).

While the conference was attended by 957 participants, it was noted that some countries sent 20's or 30's delegates and others sent only several or a couple to the conference. In order to avoid dominance of certain countries' participants in the pool of survey participants, around ten delegates were selected from those countries of which number of delegates were 10's, 20's and 30's and most or all of the delegates were selected from those countries of which number of delegates were several or only a couple. As a result, the present study selected 410 participants as a representative sample of all the participants. In narrowing down the number of survey participants, it was ensured that the selected participants' affiliations represented a balance from government and private sector.

The first-round questionnaire was sent to 410 participants. In the second-round, five people participated in a pilot test of the second-round questionnaire. As a result, the final second-round questionnaire was sent to the remaining 405 participants.

4.2 First-round Questionnaire

The first-round questionnaire was designed to elicit existing obstacles that had prevented the telecommunications development gap from being narrowed. Survey participants were asked to identify one or two of obstacles that they believed had most hindered telecommunications development in developing countries. To help them organize their responses systematically, the following framework was provided in the questionnaire.

Bernt and Weiss (1993) group international telecommunications issues into four categories: regulatory, economic, organizational and technical. The present study used this classification as a basis and added some other categories inherent to telecommunications development. The resulting categories were: 1) policy and regulation-oriented obstacles; 2) organization and administration-oriented obstacles; 3) finance-oriented obstacles; 4) technology-oriented obstacles; 5) knowledge-oriented obstacles; 6) human resources-oriented obstacles; and 7) others. The category 'others' was included to allow participants to add some other categories. Participants were asked to contribute what they believed were key obstacles by assigning them to one of the categories. The questionnaire also solicited participants' organizational affiliations and demographic information.

4.3 Second-round Questionnaire

The first-round survey identified 127 obstacles and revealed six new categories of obstacle. The second-round questionnaire was prepared to include those obstacles grouped into the following 12 categories: 1) policy and regulation-oriented obstacles; 2) planning and implementation oriented-obstacles; 3) organization and administration-oriented obstacles; 4) finance-oriented obstacles; 5) technology-oriented obstacles; 6) human resources-oriented obstacles; 7) knowledge-oriented obstacles; 8) politics-oriented obstacles; 9) economy-oriented obstacles; 10) geography-oriented obstacles; 11) social system/culture-oriented obstacles; and, 12) corruption-oriented obstacles.

In each category, a certain number of obstacles was provided with descriptions. Participants were asked to assess, by using a scale from 1 to 7, how critical each obstacle was to any effort to improve the telecommunications infrastructure in developing countries. A 1 meant "not critical" and a 7 meant "very critical."

5. RESULTS OF THE SURVEY

5.1 Participation

In the following sections, origin of participants are classified into two groups, developed countries and developing countries. While there may be several ways to group countries into developed countries and developing countries, in this study developed countries are referred to as countries that are members of the OECD (Organization of Economic and Cooperation for Development) and developing countries are non-members. In the first-round survey, 100 out of 410 responses from 54 countries were received (24.4 % return rate). A regional distribution of the responding participants is shown in Figure 1.

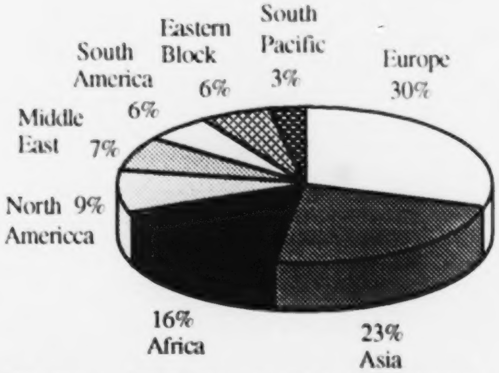

FIGURE 1. REGIONAL DISTRIBUTION OF PARTICIPANTS WHO RESPONDED TO THE FIRST-ROUND SURVEY

In the second-round survey, 90 out of 405 responses from 49 countries were received (22.2 % return rate). A regional distribution of the responding participants is shown in Figure 2.

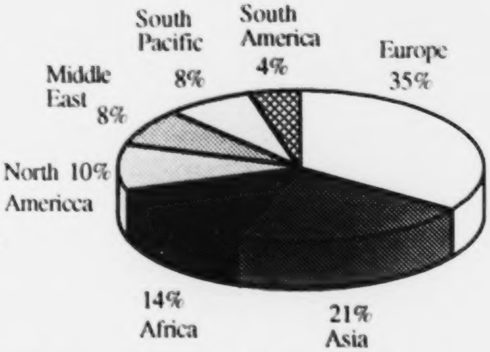

FIGURE 2. REGIONAL DISTRIBUTION OF PARTICIPANTS WHO RESPONDED TO THE SECOND-ROUND SURVEY

The two groups (developed countries & developing countries) and affiliation of participants in both first and second-round survey are summarized in Table 1. In the first-round survey, 51 responses was received from developing countries and 49 responses were from developed countries. In the second-round survey, 44 responses were from developing countries and 46 responses were from developed countries. Affiliation indicated as "others" includes representatives of international and/or regional organizations and agencies as well as consultants. Around one quarter of the participants were policy makers and/or regulators in both rounds. Around 60 % of the participants from developing countries and about 30 % of the participants from developed countries were telecommunications network operators in both rounds. Around 40 % of the participants from developed countries were manufacturers, representatives of international and/or regional organizations and agencies, and consultants.

TABLE 1 GROUP AND AFFILIATION OF THE SURVEY PARTICIPANTS

	1st-round Group		2nd-round Group	
Affiliation	Developing countries	Developed countries	Developing countries	Developed countries
A1	13 (25.5)	13 (26.5)	10 (22.7)	12 (26.1)
A2	18 (35.3)	3 (6.1)	23 (52.3)	8 (17.4)
A3	11 (21.6)	11 (22.4)	6 (13.6)	8 (17.4)
A4	2 (3.9)	5 (10.2)	– (--)	6 (13.0)
A5	6 (11.8)	16 (32.7)	3 (6.8)	11 (23.9)
A6	1 (2.0)	1 (2.0)	2 (4.5)	1 (2.2)
Total	51 (100)	49 (100)	44 (100)	46 (100)

Note. Values enclosed in parentheses represent percentage down the column.
A1=Policy maker and/or regulator; A2=Government operator and/or Government operator with operational autonomy; A3=Government and private joint operator and/or Private operator; A4=Manufacturer; A5=Others; A6=Missing.

5.2 Identified Obstacles

In the first-round survey, the participants were asked to suggest any obstacles in accordance with the given framework of the seven categories. Approximately 400 individual obstacles were identified. Since it was noted that the same kind of obstacle was addressed by several people using slightly different descriptions, those answers were consolidated. As a result, a total of 127 obstacles across 12 categories appeared as shown in Table 2.

TABLE 2 CATEGORY OF OBSTACLES

Category of Obstacle	Number of obstacles
1. Policy and Regulation	26
2. Planning and Implementation	6
3. Organization and Administration	9
4. Finance	24
5. Technology	9
6. Human resources	13
7. Knowledge	9
8. Politics	17
9. Economy	6
10. Geography	1
11. Social system/Culture	6
12. Corruption	1

5.3 Critical Obstacles

In the second-round survey, the participants assessed, by using a scale from 1 to 7, how critical each of the 127 obstacles was to any effort to improve the telecommunications infrastructure in developing countries. A 1 meant "not critical" and a 7 meant "very critical."

The degree of agreement on the assessment of the participants within each category was first checked by computing Kendall's coefficient of concordance (Kerlinger, 1986, p 273). The results showed that assessments among the participants in all categories were consistent.

Secondly, the mean and standard deviation were computed for each obstacle and then a rank order of the 127 obstacles was generated based on mean values. The higher its ranking, the severer impact the obstacles has. The following sections focus on examining the highly ranked 32 obstacles. They constitute one thirds of all the obstacles. These obstacles can be considered, from their relative positions in the rank order, to have a greater negative impact on telecommunications development efforts. Table 3 presents them in accordance with category.

TABLE 3 HIGHLY RANKED TOP 32 OBSTACLES

Category	Obstacle	M	SD
1. Policy and Regulation-Oriented (PR)	PR 1	5.53	1.17
	PR 2	5.38	1.30
	PR 3	5.37	1.28
	PR 4	5.27	1.21
	PR 5	5.23	1.25
	PR 6	5.21	1.34
	PR 7	5.17	1.42
2. Planning and Implementation-Oriented (PI)	PI 1	5.36	1.23
	PI 2	5.17	1.42
3. Organization and Administration-Oriented (OA)	OA 1	5.53	1.44
	OA 2	5.34	1.21
	OA 3	5.22	1.17
4. Finance-Oriented (FI)	FI 1	5.65	1.41
	FI 2	5.43	1.37
	FI 3	5.25	1.46
	FI 4	5.18	1.44
	FI 5	5.18	1.67
	FI 6	5.15	1.40
	FI 7	5.13	1.45
5. Technology-Oriented (TE)	TE 1	5.16	1.45
6. Human Resources-Oriented (HM)	HM 1	5.16	1.35
	HM 2	5.11	1.36
7. Knowledge-Oriented (KW)	KW 1	5.39	1.33
	KW 2	5.15	1.31
8. Politics-Oriented (PO)	PO 1	5.83	1.11
	PO 2	5.42	1.49
	PO 3	5.27	1.35
	PO 4	5.26	1.26
	PO 5	5.14	1.33
9. Economy-Oriented (EO)	EO 1	5.56	1.20
	EO 2	5.50	1.19
10. Geography-Oriented (GO)	GO 1	5.36	1.49

6. DISCUSSION OF THE 32 OBSTACLES

6.1 Policy and Regulation-oriented Obstacles

With regard to policy and regulation-oriented obstacles, seven obstacles were ranked high. They concern two issues. The first issue is that stagnant telecommunications policies and regulations in developing countries are not keeping pace with the changing environment of the telecommunications sector. The second issue is the incomplete regulatory structure in implementing a liberalization policy in some developing countries. The former is pointed out in PR 1, 2, 3, 5, 6 and 7 as follows:

PR 1: Policies and regulations in developing countries are bureaucratic and often counter-productive;
PR 2: Policy changes have not taken place in concert with technological changes and customer needs;
PR 3: Policy and regulation have not allowed the telecommunications service industry to be organized and developed as an efficient, cost-based, commercial organization, able to attract high quality staff and capital from commercial resources;
PR 5: There is a concern about privatization - concern of loss of sovereignty over telecommunication which is an important tool of social and economic development;
PR 6: There is a lack of rational liberalization policies; and,
PR 7: Policies hinder the introduction of competition and prevent regulation from being separated from the operation of telecommunications services.

The second issue is stated in PR 4 that in some developing countries, privatization is introduced without competition and/or appropriate regulations.

6.2 Planning and Implementation-oriented Obstacles

In terms of planning and implementation-oriented obstacles, the inadequate planning capability of developing countries was pointed out. That is, improper planning in developing countries results in the inefficient use of existing resources and the waste of investments (PI 1) and developing countries lack long-term oriented planning and/or investment (PI 2).

6.3 Organization and Administration-oriented Obstacles

Three obstacles result from continuing bureaucratic government control of telecommunications services in developing countries as follows:

OA 1: Government control means that there is a lack of autonomy for the operators in terms of a) investments and borrowing, b) recruitment and retrenchment, c) salaries, d) tariff setting and e) purchases;
OA 2: Organization and administration in developed countries are more open, customer-focused, market-oriented and very responsive. Whereas organization and administration in developing countries, under he pressure to build up the telecommunications infrastructure, end to be more bureaucratic and rigid; and,
OA 3: Inefficiency within the operator and/or the authorities is a result of "red tape" and a less service minded approach toward the subscribers.

6.4 Finance-oriented Obstacles

Seven finance-oriented obstacles were ranked high. They concern two issues. The first issue addresses the small financial resources allocated to the telecommunications sector in developing countries. There seems to be two reasons for this. The first reason is that telecommunication service revenues in developing countries are not appropriately dedicated to development of telecommunications infrastructure (FI 1). The second reason is that the small national budgets in developing countries restrict total investment in telecommunications as represented in the following items:
FI 2: To reduce the gap, most developing countries must accelerate telecommunications network growth from three to four per cent per year to around ten per cent. This will require devoting at least one to two per cent of GNP to telecommunications investment. This demand for capital will obviously tax all available resources;
FI 3: The lack of sufficient financial resources in developing countries does not allow them to keep up with changes in technology;
FI 4: Small national budgets in developing countries restrict total investment in telecommunications, even if priority is given to telecommunications;
FI 5: The governments or monopoly telecommunications operators do not have the financial resources to put in the basic infrastructure; and,
FI 6: National investment priority for telecommunications in developing countries is low.

The second issue is related to developed countries. The funding level from bilateral and multilateral sources is greatly inadequate to narrow the gap (FI 7).

6.5 Technology-oriented Obstacle

The most highly ranked technology-oriented obstacle is related to technology transfer from developed countries to developing countries. There is a gap of understanding and practice of "technology transfer" between developed and developing countries. Developed countries usually regard it as "turn-key" commercial sales; developing countries also need knowledge and information. This problem fosters their dependence (TE 1).

6.6 Human Resources-oriented Obstacles

The highly ranked human resources-oriented obstacle is associated with the inefficient use of human-resources as follows:
HM 1: Corruption and nepotism minimizes efficiency and the optimal use of human resources; and,
HM 2: High staff turnover is a problem in developing countries with strong economic growth. Given the relative scarcity of trained personnel to start with, this environment makes it difficult to plan for continuity and the build up of expertise.

6.7 Knowledge-oriented Obstacles

Knowledge-oriented obstacles concern the lack of impartial advice, and high cost of obtaining new knowledge represented as follows:
KW 1: There is a lack of knowledgeable and disinterested advice on various aspects of developing and operating public telecommunication networks. This includes issues such as regulating the sector, implementing a phased program of deregulation, and restructuring, including the introduction of competition; and,
KW 2: The cost of obtaining knowledge is very high due to rapid technology changes.

6.8 Politics-oriented Obstacles

Politics-oriented obstacles address two issues. The first issue concerns political instability and politicians' continuing support of the monopoly system and is represented in the following items:
PO 1: The lack of political stability in most developing countries widens the gap because financiers are not willing to risk their finances in unstable countries;
PO 2: Many politicians do not understand that if they abolish the monopoly system and allow for strong foreign cash flow in new private companies, their countries will rapidly benefit from much better telecommunications services;

PO 3: Self-financing of network expansion in developing countries is severely restricted by the politically motivated low-price supply of telecommunications services; and,

PO 5: For many reasons, but often in large part as a result of rejecting colonial approaches, politics in developing countries has generally focused on social and command economies, rather than economic and market mechanisms that facilitate private business growth.

The second issue is the lack of a holistic viewpoint about the role of telecommunications and the low national priority for telecommunications. Even if an efficient telecommunications infrastructure is one of the most important prerequisites for the development of an economy and for the development of other areas such as transport, agriculture, health and education, telecommunications tend to be looked at in isolation (PO 4).

6.9 Economy-oriented Obstacles

Economy-oriented obstacles are related to the adverse economic condition of the telecommunications sector in developing countries as represented in the following items:

EO 1: The economic situation in developing countries often forces the government to give a greater priority, in allocating available resources, to those services related to the basic needs (food, clothing, and shelter); and,

EO 2: The economies of developing countries do not allow them to invest much in the development of their telecommunications networks.

6.10 Geography-oriented Obstacle

Finally, geographical conditions are a big hindrance to telecommunications development in some developing countries. In developing countries, the rural life style of people scattered throughout a wide geographical area results in the requirement for very heavy investment to give service to very small numbers of people. This is not commercially justifiable and presents a huge burden for the operator (GO 1).

6.11 Top Five Obstacles

Across the categories, followings are the top five obstacles:

PO 1: The lack of political stability in most developing countries widens the gap because financiers are not willing to risk their finances in unstable countries;

FI 1: Telecommunication service revenues in developing countries are not appropriately dedicated to development of telecommunications infrastructure;

EO 1: The economic situation in developing countries often forces the government to give a greater priority, in allocating available resources, to those services related to the basic needs (food, clothing, and shelter);

PR 1: Policies and regulations in developing countries are bureaucratic and often counter-productive; and,

OA 1: Government control means that there is lack of autonomy for the operators in terms of a) investments and borrowing, b) recruitment and retrenchment, c) salaries, d) tariff setting and e) purchases.

The first three obstacles are serious problems in many developing countries. The fact that these problems cannot be coped with by the telecommunications sector alone makes it harder for the sector to find out immediate solutions. The fourth and fifth obstacles, however, could be overcome by concerted efforts and a clear direction within the sector. Even if all the obstacles cannot be eliminate at once, there are still many obstacles that could be tackled.

7. IMPLICATIONS OF THE STUDY

One way to improve the unfavorable telecommunications situation is to identify obstacles to further development, and then to eliminate, or at least, to reduce the negative impacts of as many obstacles as possible. Without understanding what have prevented development, we will likely to repeat the same inefficient and unsuccessful efforts. Conversely, once we understand what the real problems are and where they come from, we can be in a much better position to make our efforts more productive. The current study has identified key barriers to the efforts toward further telecommunications development. Professionals who are involved in the telecommunications development in developing countries should diagnose obstacles and prescribe appropriate actions to overcome them so that they can succeed in their projects. This study provides an essential first step toward this direction.

8. POSSIBLE APPLICATIONS OF THE FINDINGS

Developing countries should assess existing obstacles before taking any new action toward telecommunications development. They need to recognize that many of the 32 obstacles identified and prioritized in this study result from their own internal problems. Although some of the obstacles, such as the small national budget and the adverse economic and geographical conditions, may be beyond the control of telecommunications professionals, other obstacles, such as the stagnant policies and regulations, bureaucratic government control and the inefficient use of human resources, should be eliminated by concerted efforts.

Developed countries can assist developing countries to overcome some problems, especially in the areas of planning, regulatory restructuring, finance and technology. While it is true that much assistance has been carried out in these areas, it is questionable whether the assistance has been directed to eliminating the obstacles. Developed countries should reexamine whether their efforts have been functioning to effectively eliminate these obstacles. As long as the barriers to further development are only indirectly tackled, the developed countries' assistance will not bring significant impacts on telecommunications development in developing countries.

Some of the obstacles seem to be caused by misunderstandings between developing countries and developed countries. According to the study, the different perspectives were observed in technology-oriented obstacles and knowledge-oriented obstacles. Before the misunderstandings are further compounded, both developing and developed countries need to discuss what their perceptions about those problems are and to discuss what solutions should be taken.

Whenever an official assistance project is carried out or a foreign private provider is entering the market in a developing country, potential obstacles should be first assessed individually by the developing country's side and the developed country's side. Then their assessments need to be discussed jointly. This process should bring a better understanding of the real problems, and as a result, lead to more effective and productive approaches to solve the problems.

9. CONCLUSION

The current study has identified 127 obstacles across 12 categories and discussed the top 32 obstacles. While approximately half of the 32 top ranking obstacles are somewhat similar to what had already been found in earlier studies, the other obstacles, especially in the categories of technology, human resources and knowledge, were newly identified in this study. These 32 obstacles can be assessed as the most critical obstacles to telecommunications development. In addition to the individual obstacles, the ten categories of obstacles in Table 3 indicate the different dimensions of the problem.

Since each country has different challenges with regard to telecommunications development, it is necessary to identify the inherent obstacles on a country-by-country basis. Unless telecommunications professionals understand the real mix of problems, they cannot prescribe appropriate solutions furthering telecommunications development. The ten categories and the 32 obstacles in the present study, however, will provide a valuable framework within which professionals can diagnose potential problems and prescribe more appropriate actions.

10. REFERENCE

Bernt, Phyllis, & Weiss, Martin. (1993). International telecommunications. Carmel, Indiana: Sams.

Chowdary, T. H. (1992). Telecommunications restructuring in developing countries. Telecommunications Policy, 7, 591-602.

Hudson, H. E. (1983). The role of telecommunications in development: A synthesis of current research. In O. H. Gandy, P. Espinosa, & J. Ordover (Eds.), A Proceedings from The Tenth Annual Telecommunications Policy Research Conference (pp. 291-307). Norwood, NJ: Ablex.

Independent Commission for Worldwide Telecommunications Development (The Maitland Commission). (1984). The missing link. Geneva: ITU.

International Telecommunication Union (ITU). (1994a). World telecommunication development report. Geneva: ITU.

International Telecommunication Union (ITU). (1994b). World telecommunication development conference final report. Geneva: ITU.

Kerlinger, Fred. N. (1986). Foundations of behavioral research (3rd ed.). Fort Worth: Harcourt Brace Jovanovich College Publishers.

Lichauco, J. T. (1994). Forging new links Philippine style. PTC'94 Plenary Presentations (pp. 14-19). Honolulu: Pacific Telecommunications Council.

Maitland, D. (1994). Forging new links - Focus on developing economics. PTC'94 Plenary Presentations (pp. 1-5). Honolulu: Pacific Telecommunications Council.

Parker, E. B. (1992). Developing third world telecommunications markets. The Information Society, 8, 147-167.

Tabai, I. T. (1994). Telecommunications in the Pacific. PTC'94 Plenary Presentations (pp. 41-43). Honolulu: Pacific Telecommunications Council.

Tarjanne, P. (1994). The missing link: Still missing?. PTC'94 Plenary Presentations (pp. 6-13). Honolulu: Pacific Telecommunications Council.

Wellenius, B. (1989). The impact of modern telecommunications. IEEE Technology and Social Magazine, 8(4), 3-6.

THE BUILDING BLOCKS FOR COMPETITIVE INFORMATION INFRASTRUCTURE

Andrew D. Lipman
MFS Communications Company
Washington, D.C.

1. ABSTRACT

Based on the experiences of MFS Communications Company, both in the U.S. and in other world markets, the paper first provides a brief overview of the status of local services competition and the public policy issues raised by initiation of local competition. The paper then describes the new local switched services co-carriers. Finally, it details the legal and technical requirements that must be satisfied in order to give telecommunications users the proven benefits of telecommunications market entry by competitive infrastructure providers.

2. CO-CARRIERS: NEW PLAYERS IN THE TELECOMMUNICATIONS ARENA

MFS Communications Company (1) is a new kind of company, competing with long-established dominant market carriers on the basis of quality, customer service, and price, and committed to the introduction of innovative new services never before available. Urged on by MFS and other potential market entrants, not only a rapidly growing number of state regulators in the United States but also a rapidly growing number of telecommunications regulators throughout the world are allowing new entrants to provide a full range of services and become "co-carriers" whose networks are fully interconnected with the networks of the former monopoly carriers. In the U.S. and in many other countries, the debate has now shifted from the issue of whether to allow local competition to the issue of when and how to allow local competition.

Following a brief overview of the status of local services competition in a number of world markets, based on MFS's experience in "pushing the regulatory envelope," both in the U.S. and abroad, this paper examines the nature and requirements of local switched service co-carriers that must be addressed by regulators in order to give telecommunications users access to the proven benefits of co-carriers' market entry.

3. DEVELOPMENT OF LOCAL COMPETITION

Historically, local telecommunications infrastructure was considered a natural monopoly, not susceptible to competition or overbuild. Over the past century, both in the U.S. and abroad, laws and concessions were drafted and enforced which ratified that concept and expressly prohibited competitors from constructing their own local infrastructures. These practices, in turn, led to the evolution of local telecommunications monopolies, which demonstrated relatively little interest in price competition or the development of new information technologies.

In the past several years, however, the economies of scale of fiber optics and digital switching have made local competitive infrastructure both feasible and financially attractive. Telecommunications policy makers have therefore opened the local infrastructure to competition in such diverse locales as Australia, Chile, Denmark, Hong Kong, Japan, Mexico, Sweden, and the United Kingdom, (2) as well as a rapidly increasing number of U.S. states. Not only are telecommunications carrier market entrants being allowed to construct infrastructure, but also cable television service providers and power and railroad utilities with existing infrastructure are being authorized to offer local services in competition with the former monopoly carriers. (3) With few exceptions, competition has initially been permitted by only a few entrants and/or in technically or geographically limited service markets. The substantial demonstrated benefits to consumers are rapidly resulting, however, in a broadening of the permitted service parameters until full co-carrier competition has been authorized.

4. LICENSING CONSIDERATIONS

The challenge for regulators considering authorization of local competition has been to ensure the availability to telecommunications users of the advanced, cost-efficient services they need while avoiding major social and political disruptions. In making the decision to introduce local infrastructure competition, regulators around the globe have had to face many common social policy issues -- rate re-balancing, employment consequences, privatization, and foreign investment standards -- as the introduction of competition raises issues of foreign participation in a telecommunications market formerly closed to all but a single, usually government-owned, carrier.

Universal service concerns have attracted particular attention. In many countries, such as Brazil and many parts of the United States, excessively high long distance rates have long kept local rates artificially low. This has masked the degree to which dominant carriers have found themselves burdened by excessive labor costs and inefficient networks and blunted the demand for local competition. As long distance rates are re-balanced, however, and become subject to competition to satisfy user demands for pricing and functionalities they can receive in other countries that are critical to the competitiveness of their core businesses, (4) local prices rise. This leads to concern that service availability will be restricted if local service is priced at a level that recovers its costs and makes a profit. (5) Regulators have therefore been exploring various alternatives such as universal service subsidies and direct payments to a fund for direct supplements to low-income subscribers that preserves these consumers' access to a choice of carriers while providing opportunities for more efficient providers to enter the market, using state-of-the-art infrastucture.

As this example illustrates, regulators increasingly are coming to the conclusion that the benefits of local competition warrant their efforts to develop such creative solutions to the implementation problems.

5. BARRIERS TO CONSTRUCTION OF COMPETITIVE INFRASTRUCTURE

Once the not-insignificant regulatory hurdle of authorization of local competition is overcome, a number of other factors still inhibit the development of competition. In many cases, even where a national regulator wishes to encourage competitive infrastructure competition, its limited authority prevents it from removing these special entry barriers. Where a potential services provider does not operate existing cable television or utilities infrastructure, the award of a regulatory license may be only the initial step in constructing a network.

For example, paralleling its experiences in local U.S. markets, although MFS received the first license to construct local infrastructure for the provision of liberalized services in Germany, it still must negotiate franchises with individual city governments in order to obtain the access to right of way necessary to construct the network. Unlike the situation in the U.K., where MFS's license conveys the same "code powers" for wayleaves available to British Telecom, MFS's German license only opens the door to right-of-way negotiations. Similarly, while dominant carriers have universal building access to serve all residences and commercial buildings on their networks, new market entrants may have to pay fees for building entrance rights. Given the necessity of paying for such right-of-way access, MFS clearly has substantial expenses the dominant carrier is free of.

Infrastructure construction is further complicated by the necessity of obtaining permits for street cuts and closures, even where there are no special complications of environmental requirements or historic preservation restrictions. Other entry barriers may be special tax advantages enjoyed by the incumbent operator or special exemptions from local zoning restrictions that do not extend to competitive service providers.

In many cases, as in both Mexico and the U.S., legislative solutions are being adopted to address some of these inequities in order to promote competition. For example, Mexico's new Federal Telecommunications Law provides for sharing of utility poles with new telecommunications network concessionaires on a nondiscriminatory basis. Legislation pending before the U.S. Congress would limit local franchise fees and set pole attachment rates applicable to new telecommunications service providers.

6. INTERCONNNECTION AND OTHER CRITICAL CO-CARRIER OPERATIONAL ISSUES

6.1 WHAT CO-CARRIER STATUS MEANS

Once these hurdles are overcome, and physical construction of a competitive network is feasible, there are a number of significant interconnection and related issues (which MFS has termed "co-carrier" issues) that must be resolved in order to promote the development of local switched services competition. In particular, it is necessary to implement physical and procedural mechanisms for the exchange of switched local traffic on a "universal" basis--that is, with all competing carriers having the ability to serve all subscribers in a metropolitan area over a competitor's facilities, or through a combination of the competitor's network and that of the incumbent provider. In a growing number of U.S. jurisdictions, incumbent local exchange carriers ("LECs") and competing carriers meeting specific requirements for local competition may obtain co-carrier status.

The co-carrier concept, born about two years ago in the United States, grew out of the desire of local competitors to be given co-equal carrier treatment, rather than being deemed to be either end-user customers or interexchange carrier ("IXC") customers. If new entrants are forced to buy LEC services at tariffed rates, they must necessarily resell them at higher rates to cover their costs. Obviously, under such a regime, end-user customers can have no incentive to choose an alternative carrier instead of the local LEC. With co-carriage arrangements, however, the LEC must treat a competitor just like it treats a neighboring LEC, even though the local competitor may be providing service in the same geographic area as the LEC.

6.2 THE RISE OF CO-CARRIAGE

Competitors in the U.S. such as MFS initially began providing only dedicated special access services (interstate and, where allowed, intrastate) and private line services. Although state laws and policies limited the markets open to competitors, the Federal Communications Commission ("FCC") and a rapidly growing number of states have made significant policy changes in an effort to bring competition to all market segments, including the market for switched transport services.

As part of the new policies promoting competition, at both the state and federal levels, collocation of new entrants' interconnection equipment in LEC central offices was mandated, initially to interconnect networks for the purpose of exchanging traffic. Eventually, in a few jurisdictions, competitors were permitted also to provide switched services.

Although MFS wanted the authority to provide switched services in all markets it served, it was clear that interconnection terms designed for traffic exchange were insufficient for cost-efficient switched competition. Therefore, MFS began regulatory initiatives in several jurisdictions to bring these concerns to the fore and to resolve issues that related to "co-carrier" status.

6.3 A NETWORK OF NETWORKS

The national public switched network in the U.S. was built by connecting separate local and long distance networks owned by many carriers. Significantly, the networks of the Bell Operating Companies ("BOCs"), which cover many of the densely populated areas of the U.S., are adjacent to hundreds of smaller networks owned by small and medium-size independent telephone companies ("Independents"). The BOCs exchange traffic with Independents serving customers within the BOCs' own LATAs ("Local Access and Transport Areas"), compensating each other for handling traffic transferred between and among their networks by making "settlements" in much the same way as international carriers compensate one another pursuant to international correspondent agreements.

Thus, the concept of a "network of networks" is not a new one. The only new idea is that some of the carriers providing service over these different networks now seek to provide service to the same group of customers. History and industry practice thus supply the appropriate model for the connection of these new competitive local networks to the existing network.

6.4 ADOPTION OF THE CO-CARRIAGE MODEL

The first state to tackle co-carrier status was New York. Maryland, Illinois, Michigan, Texas, and Massachusetts are now establishing co-carrier arrangements. Others with proceedings underway to consider local competition issues include Connecticut, North Carolina, Iowa, Georgia, Louisiana, Arizona, and Washington. Several others, including Florida, Oregon, Pennsylvania, Virginia, Tennessee, and Ohio, are not far behind.

Very recently, a comprehensive agreement between Pacific Bell and MFS was reached in California that provides a very detailed blueprint for implementation of co-carrier arrangements. (6) A similar process is now underway in Canada, whose regulator has mandated local competition and has initiated proceedings to implement the local competition policy. (7)

6.5 INTERCONNECTION, A FUNDAMENTAL REQUIREMENT OF CO-CARRIERS

MFS, long the leading co-carrier in the U.S., is also in the forefront of the co-carrier debate abroad. (8) As MFS's experience demonstrates, the issuance of a regulatory license is only the first step toward service provisioning. Throughout the world, as in the U.S., if a license does not automatically convey co-carrier status (as it now does in Maryland and New York, for example), the new entrant must negotiate with both regulators and dominant carriers for interconnection terms and conditions that will allow it to operate as a co-carrier providing a full range of services to its customers. Market entrants overseas grapple with the same issues of interconnection, number portability, network unbundling, open network provisioning, mutual compensation, etc. presented in North America.

Government-mandated and government-monitored interconnection arrangements are thus a prerequisite for effective competition, as the FCC recognized in its recent decision making such regulator-supervised interconnection a cornerstone of its new "effective competitive opportunity" test. (9) Where, as in New Zealand, entry has been permitted but there has been a "hands-off" regulatory approach, competition may be thwarted by the absence of these essential arrangements. (10) As evidenced by Mexico's new Federal Telecommunications Law, the trend appears to be toward establishment of mandatory interconnection obligations as a central tenet of the regulatory scheme. (11) To make its regulation more effective, Chile recently separated its telecommunications policy-making body from its enforcement body.

7. SIX ESSENTIAL TYPES OF CO-CARRIER ARRANGEMENTS

Theoretical liberalization alone, without clear standards for licensing and interconnection, is insufficient to ensure that new companies can actually enter the markets for competitive services. (12) In MFS's view, apart from regulatory authorization of infrastructure and services competition, six types of arrangements must be available before a competitive access provider can compete successfully with incumbent LECs or dominant national carriers. MFS has identified these arrangements, described below, as: number resource availability; meet-point billing; shared platforms; local number portability; unbundled link; and reciprocal traffic exchange.

7.2 NUMBER RESOURCE ARRANGEMENTS

A co-carrier must have non-discriminatory access to and use of central office ("NXX") codes pursuant to industry guidelines. Necessary number resource arrangements also include competitive neutrality in dialing arrangements (the same number of digits) as well as neutral administration of the national numbering plan and associated numbering routing and billing/rating functions and processes at both the local and national levels. Various national regulators, such as Sweden's, have found it useful to convene industry workshops to address numbering issues.

7.3 MEET-POINT BILLING ARRANGEMENTS

To the extent the dominant carrier enters into arrangements with independent contiguous carriers for billing the individual portion of a joint service offering (meet point billing), that same arrangement must be made available to the new entrants. Similarly, when contiguous carriers are allowed to use an incumbent's switch as a point of aggregation to reach numerous end offices, similar arrangements must be offered to the co-carrier.

7.4 SHARED PLATFORM ARRANGEMENTS

The co-carrier should be able to integrate its network into the pre-existing arrangements governing emergency services and enhanced emergency services telecommunications relay services (known as "911" and "E911" in the U.S.) directories. Various existing platform such as data bases are the result of the incumbent's monopoly position. It would be inefficient to require the duplication of platforms for directory assistance services, audiotex, billing and collection arrangements, and operator services. Thus, for example, the license of Telstra, the dominant carrier in Australia, requires it to supply operator and directory services to other carriers.

7.5 LOCAL NUMBER PORTABILITY ARRANGEMENTS

Experience has shown that customers, especially businesses, have strong proprietary interests in their telephone numbers. The costs of reprogramming premises equipment and of revising advertising and other promotional or written materials discourage customers from changing local carriers, even if the new carrier can offer a superior service at a lower price. In the U.K., for example, the lack of number portability was cited as a major obstacle to the growth of cable operators' telephony services, and the regulator has now required implementation of portability.

Interim local telephone number portability (which may be based on remote call-forwarding arrangements transparent to the user) (13) allows customers to retain their telephone numbers when switching carriers. The ultimate solution is true number portability. This permits businesses to change local exchange providers and have their numbers actually assigned to the new carrier. This system is already available in the U.S. for "800" services. The Mexican law provides for establishment of number portability once the government finds it technically and economically feasible, and Canada has a pending number portability proceeding. (14)

7.6 UNBUNDLED DISTRIBUTION FACILITIES

"Loop unbundling" refers to making available to co-carriers, on a discrete element and reasonably priced basis, portions ("arrangements") of the exchange provider's local distribution network necessary to allow new entrants to provide services to customers in buildings that are not on their networks. (15) These arrangements include transport links, cross-connections (between providers' networks), and dialtone-generating switch ports for all exchange access services, including basic lines/trunks, Centrex, and digital and ISDN capabilities. All transport-based and switch-based features, functions, service attributes, grades-of-service, installation, and maintenance and repair intervals that apply to the bundled service should apply to unbundled links and ports. Furthermore, rollover or conversion of unbundled elements should not be penalized.

The complexity and criticality of these network unbundling issues was emphasized in a speech by the U.S. Assistant Attorney General for the Antitrust Division of the Department of Justice, Anne K. Bingaman. She stated,

> We recognize, however, that no set of conditions for promoting [local] competition could hope to address in advance the dozens and dozens of complicated implementation issues that will require resolution before meaningful competition is a practical reality, rather than merely a theoretical possibility. . . . To say that unbundling must take place, for example, begs the questions of the price of the unbundled network elements, the relation between those prices and the retail price of the bundled service and what sort of volume discount structure can be applied to either set of prices. The answers to these questions in turn will determine the marketplace effectiveness of the unbundling. (16)

In those U.S. markets where co-carrier status is now a given, the debate has shifted its focus to address these details of implementation, which can make or break a potential market entrant's business opportunity.

7.7 RECIPROCAL TRAFFIC EXCHANGE AND COMPENSATION ARRANGEMENTS

The sixth co-carrier arrangement, reciprocal traffic exchange and compensation, requires significant restructuring before fully effective local exchange competition can develop. While the ideal solution will take time, the public interest requires that entry be allowed in the very near term. Both long-term solutions and interim solutions such as "bill and keep" are therefore required.

Reciprocal traffic exchange and reciprocal compensation are two sides of the same coin. Compensation will never be truly "reciprocal" unless the arrangements by which competing carriers connect their networks and exchange traffic between their end users are also reciprocal, as well as technologically and competitively neutral. The U.K. experience with the inferior Mercury telephone "blue button" arrangement illustrates the need for ensuring that new entrants are not given second-class status.

Thus, the long-term goal must be to develop and implement a competitive and technologically neutral traffic exchange and reciprocal compensation plan that will permit the development of effective local exchange competition; create incentives for, and allow carriers to configure, robust, high-quality, least-cost, efficient networks; encourage efficiency, innovation, improved service, and customer responsiveness; and ensure optimal interoperability and service transparency to end users.

Any traffic exchange arrangement should adhere to certain basic underlying principles. Each carrier should be able to decide its own basic business strategies and take sole responsibility for its decisions with respect to network design, technology and capital deployment, management of operating expenses, and product offering selection.

7.8 LONG-TERM COMPENSATION SOLUTIONS

MFS favors a long-term solution in which competing local carriers would exchange traffic at designated, mutually agreed, competitively neutral meet-point locations. Each carrier would be responsible for delivering and receiving traffic from other carriers at such meet-points, with all compensation occurring under a standardized compensation structure.

In this manner, each carrier would be free to configure its own network behind or beyond the meet-points in whatever manner it determines will best serve the needs of its customers. Ideally, in a fully and effectively competitive local service market, all traffic would be exchanged at established meet-points at a single rate per minute, which would essentially reflect an economically optimal "half-call" rate.

7.9 INTERIM APPROACHES

Owing to decades of artificially reinforced monopoly, the current situation is far from ideal, and the local playing field is tilted heavily in favor of the incumbent dominant monopolies, whether they are BOCs, Independents, or Post Telegraph and Telephone Administrations ("PTTs"). Even liberalized markets are characterized by a lack of true local number portability and end user rates that are inconsistent with self-imputation by dominant carriers of the charges imposed on co-carriers. Consequently, setting a compensation rate at an ideal level in this less than perfect situation will not encourage the development of effective competition in local services.

Until at least the full implementation of true local number portability, local traffic should be exchanged and calls should be completed between competing local carriers under an "in-kind exchange" or "bill and keep" arrangement.

New entrants and incumbents would exchange traffic by extending Feature Group D-type (17) terminating access arrangements to one another, per the incumbent carrier's existing tariff for access services, except that no charges would apply to local calls. In the U.S., in an arrangement similar to that applied to IXC arrangements, each co-carrier would be responsible for reporting the percentage of local use ("PLU") each quarter, just as U.S. IXCs report the percent of interstate use ("PIU") factors. There would be no segregation of trunk groups.

A "bill and keep" arrangement, whereby each co-carrier bills and collects charges for call originations from its own subscribers, regardless of whether a call terminates on another carrier's network, has several advantages in the near term. The system is simple to administer and is consistent with, and can be imputed into, any type of end user local rate structure currently in place, including flat-rate local calling plans. It may also partially level the playing field by somewhat mitigating the disadvantages new entrants will face as they attempt to enter the severely imbalanced and currently monopolized local switched services market. Finally, this arrangement will create strong incentives for incumbent LECs to participate aggressively in the development and implementation of true local number portability.

8. PUBLIC BENEFITS OF CO-CARRIER ARRANGEMENTS

Regulators in North America, Latin America, the European Union , and Asian and Pacific Rim countries are concluding that at least some form of local services competition should be developed as quickly as possible. They recognize that, in the domestic and international long-distance market, as well as throughout virtually all sectors of the economy, competition has led to better quality services, lower prices, and increased innovation. Innovation, economic value, and new job creation often come from new entrants and not from slower-moving, mature enterprises. Moreover, the availability of local services competition in markets around the world will allow customers to select a single carrier to meet global telecommunications network and service requirements, permitting seamless end-to-end network management that will make feasible advanced service features and customized offerings not currently available.

Local services competition will also open to all types of end users the benefits of a choice of carriers and can apply a competitive spur to higher quality service to the existing dominant carriers. The efforts of dominant carriers to improve service, upgrade their facilities, and lower their prices in markets that are only scheduled to be opened to competition demonstrates that, regardless of their size and headstart, these carriers will have to enhance their range of services and the cost-effectiveness of those services in order to compete with aggressive new market entrants.

9. CONCLUSION

The development of effective co-carrier arrangements represents an integral aspect of the creation of a competitive local switched services market, which, like long distance competition, will have important benefits for the global economy. MFS's extensive experience suggests that many co-carrier issues can be resolved rather easily. Co-carrier issues that require further work have been successfully addressed on an interim basis, accelerating the introduction of local exchange competition.

Absent effective regulatory oversight, however, potential local competition will be forestalled. Given the fundamental importance of low-cost, state-of-the-art telecommunications infrastructure and services to economic development, it is essential that regulators take a leading role in ensuring the rapid implementation of the conditions essential to the development of effective local services competition so that end-users worldwide can reap the myriad benefits of local competition.

ENDNOTES

1. MFS, through its subsidiaries, is authorized to provide service in all 50 states. Through its international carrier subsidiary, MFS International, Inc., and MFS International's subsidiaries, MFS is providing international services worldwide, as well as domestic services in a rapidly-growing number of countries outside the U.S.

2. For example, Australia now has a duopoly regime, but the market is scheduled for full liberalization in July 1997. In Chile, Santiago has two local infrastructure-based carriers competing with the dominant carrier. Denmark already permits new entrants to construct broadband networks, and full liberalization is scheduled for mid-1996. In July, Hong Kong licensed three new competing local service providers. Japan has had local competition for NTT since 1985. Mexico is rapidly developing regulations to implement its 1995 Federal Telecommunications Law so that competition can commence as soon as the exclusivity provisions of TelMex's concession expire in August 1996. Sweden, which never had a *de jure* telecommunications monopoly, issues Public Telecommunications Operator ("PTO") licenses authorizing local as well as long distance and international services competition. The United Kingdom has licensed multiple carriers to provide competitive local and other services as PTOs, restricting to the British Telecom/Mercury duopoly only international, non-satellite facilities ownership. Full liberalization of the telecommunications markets of the EU countries and Switzerland is scheduled for 1998.

3. For example, use of cable infrastructure for all telecommunications services other than the switched voice services reservation is to be effective January 1, 1996. Railroad operators in Germany and the Netherlands have announced plans to convert their private networks to offer commercial services.

4. In Germany, VEBA AG's telecom subsidiary was recently licensed (following EU intervention) to operate an SDH-based broadband network because Deutsche Telekom does not offer the service.

5. The Federal Communications Commission and U.S. state regulators recently launched a joint inquiry into universal service issues. *Amendment of Part 36 of the Commission's Rules and Creation of a Joint Board*, CC Docket No. 80-286. The EU is scheduled

to issue a "communication" on universal service in December 1995.

6. Advice Letter Compliance Filing for Co-Carrier Interconnection Agreement, No. 17879, California Public Utilities Commission, November 20, 1995.

7. Telecom Decision CRTC 94-19, Review of Regulatory Framework (Sept. 19, 1994).

8. For example, in Sweden MFS is authorized to provide the same range of local, long distance, and international wireline telecommunications services as Telia, long the dominant national provider. In the U.K., the only limitations on MFS's Public Telecommunications Operator license are prohibitions on the provision of international facilities-based services and simple voice resale to non-designated countries, provisions that will expire in 1997. In Germany, MFS was recently licensed to build infrastructure for liberalized services and is constructing several networks. MFS has also received a license to construct infrastructure for similar services in La Defense in Paris.

9. On November 28, 1995, the FCC adopted a new "effective competitive opportunity" test for entry and expansion of non-U.S. carriers in the U.S. international services market. *FCC News*, "FCC Adopts New Rules on Foreign Carrier Entry Into U.S. Markets" (Nov. 28, 1995).

10. In New Zealand, which had adopted an unrestricted but unregulated entry policy, the second duopoly carrier was unable for four years to reach an interconnection arrangement with the dominant carrier. Japan is currently investigating complaints that NTT will not enter into interconnection agreements.

11. Article 43 of Mexico's new telecommunications law provides for a short period for interconnection negotiations, with government mediation if the parties do not reach agreement. The law itself specifies many of the standards for interconnection. Similarly, Denmark has made establishment of an interconnection plan and an independent regulatory body, as well as a universal service fee, part of the first phase of its liberalization scheduled for mid-1996.

12. Therefore, under the leadership of the Commissioner for Competition of the European Union, Karel Van Miert, the EU in July 1995 proposed a directive that would require all Member States to publish by January 1997 legislation that will authorize full competition in telecommunications infrastructure and voice telephony by January 1998. The required national legislation must include provisions not only on authorization of service providers but also on interconnection arrangements and sharing of obligations for provision of universal service.

13. "Remote call forwarding" technology routes calls to the former service provider based on the continuing assignment of the number to that carrier, but the carrier forwards the call to the new service provider based on information in its data base indicating that the customer has switched carriers. One such interim solution, known as "co-carrier number forwarding," was recently endorsed by the New York Public Service Commission and implemented in agreements between the local BOC (Nynex) and several New York co-carriers, including MFS. Under this arrangement, terminating access charges flow through to the actual terminating carrier.

14. *See* Public Notice, CRTC 95-48, Implementation of Regulatory Framework -- Number Portability and Related Issues.

15. In New York, which has led the way in local loop unbundling in the U.S., most of the outstanding issues concern pricing. In other states that have issued certificates to co-carriers or competitive LECs, only interim physical unbundling arrangements are in place.

16. Remarks of Anne K. Bingaman, "Promoting Competition in Telecommunications," Feb. 28, 1995, before The National Press Club, Washington, D.C.

17. "Feature Group D" is the U.S. term for the trunk-side switched access connection developed to make available to other carriers the same quality of features and pricing given to AT&T following the Divestiture. It allows pre-subscription to the long distance carrier of the subscriber's choice for "1+" (*i.e.*, automatic) access to that carrier.

Privatization: A Strategic Management Perspective

Diane Landau
President, Global Resources
Bridgewater, NJ & Corona del Mar, CA USA

I. ABSTRACT

As nations privatize telecommunications operators, strategic efforts have traditionally focused on financial concerns and the need for sector and business reform. However, in a global context, privatizations are increasingly competitive and telecom operators offer different incentives and messages to global investors who are continually evaluating competitive investment possibilities. It is therefore critical that a nation manage its privatization process strategically through a multi-tasking process that allocates activities and functions to the appropriate *center of organizational activity* over an extended period of time. A nation must ensure that the messages it sends the global public are the ones it wants potential bidders to hear. Similarly, if foreign investment is not particularly desired, then the telecommunications privatization needs to be managed in a strategic manner which affords the nation the opportunity to expend internal government and business resources in a private and effective manner which is not swayed by the desires and activities of outside (and sometimes conflicting) forces.

Privatization: A Strategic Management Perspective

As countries look for alternatives to ill-functioning telephone systems that are being run by government or quasi-government agencies, many turn towards privatization. In 1984 the British government caught the attention of worldwide policymakers with the public sale of $4.9 billion worth of shares in British Telecom. In 1986, Nippon Telephone and Telegraph (NTT) raised the stakes when the Japanese telco astounded investors by selling for $12.4 billion. The privatization trend continued with the private sale of Telecom New Zealand ($2.5 billion, 1990) and the well-publicized sale of Telefonos de Mexico ($2.2 billion, 1991); indeed, by 1991, it was estimated that governments raised some $50 billion by selling state-owned firms to private investors.[i]

By 1993/1994, investors began to review investment returns. Equity value increases such as 138% (Telecom New Zealand), 230% (Telmex) and 460% (CTC/Chile)[ii] strengthened many a policymaker's desire to "privatize". But what exactly is privatization? What makes a privatization effective?

Over the last four years, *Global Resources* has trained over 70 senior telecommunications managers from developing and emerging nations in telecommunications privatization concepts. When managers are surveyed at the beginning of the course, most of the 70 students have stated "that they are taking the course to learn about privatization. They believe privatization will provide the funding and catalyst for the changes needed in their telecommunications sector. They need to make their sector more efficient and profitable".

As the course progresses, the training program reviews differing telecommunications sector reform models and various country experiences with privatization; the intent is to show managers the tremendous diversity in telecommunications sector management models and the complexity involved in managing sector change. Students share their own professional experiences and within a few days, the difficult realities of managing inter-related telecommunications network, regulatory and government activities in developing countries are being openly discussed.

Inevitably, the students reach a conclusion which is part of the course's teachings. In order for a privatization to be effective, it must be part of an overall movement of national reform. They realize that as unique or profitable as they perceive their own country's telecommunications privatization to be, as they look around the classroom, they are facing competitors. Worse, there are more countries privatizing their telecommunications operations than there are investors. What happens if they privatize and nobody bids to buy? What if the sale does not attract the type of buyer they want? Students then turn to the instructor and modify their original question. They ask, 'What can we do to make a privatization more attractive to outside investors?".

Privatization: A Strategic Management Perspective

Privatization is the sale of a government asset. In telecommunications, the State's general failure to efficiently and effectively manage the sector has caused telecommunications entities to be aggressively considered for privatization. Technological change, changes in demand and industry concentration, and a general industry diversification have created new products and services and new dynamics in decision-making, purchasing, and international trade. Similarly, it has also caused traditional government ownership and management models for telecommunications to come into question; privatization has been offered as one of many solutions of sector reform.

While the privatization concept may sound simple, those familiar with the activity know that it is a complex and often frustrating process. There are numerous dialogues and decisions that must take place before a privatization begins, but once committed to, experiences to date have provided answers as to how to manage the privatization activity. N. Miller's 1991 paper[iii] provides a good summary:

Phase 1: Get Organized
Phase 2: Define the Specific Goals for Restructuring
Phase 3: Seek Out the Potential Bidders and Prepare the Company for Sale
Phase 4: Negotiate the precise Terms of Sale with the Successful Bidder
Phase 5: Prepare and Execute the Closing
Phase 6: Implement the transition to private ownership and operation and new governmental oversight and regulation of the sector

But how does a nation approach this process? Who should manage each phase and its associated tasks? Should the telecommunications service provider seek the bidders or is it the Ministry of Finance's responsibility? Who should work with the consultants? If this is a process of reform, is it the national government's responsibility to manage a telecommunications privatization? What part of the government? How well can any one government official understand the complexities of privatization management when a telecommunications service provider, telecommunications regulator, government ministries, and numerous public, network and international issues are involved?

Generally, governments have tended to privatize companies in an effort to achieve one, two or several objectives. From a *financial* perspective, the government's goal may be to raise government revenues or create a business environment where future government outlays can be reduced. *Economically*, three goals predominate in a privatization: to increase an organization's efficiency[iv], performance and usually, its ability to innovate. From *a developmental* perspective, privatization can be used to enhance domestic capital markets or to distribute share-holder equity. In telecommunications, the goals usually include all of these with additional objectives: the desire to extend service, create new jobs (or lose as few as are possible), attract quality technology transfer and/or investment, introduce a competitive discipline, allow for autonomy and a commercial orientation of the firm, attract entrepreneurial talent, etc. As many telecommunications managers know, in a developing nation, the list of goals can sometimes appear endless.

Because there are multiple objectives, successful privatizations generally involve multiple individuals and institutions within a society and its working politic. When we think about the three groups of privatization objectives -- financial, economic and developmental -- we can see a natural parallel to three types of business and policy institutions that generally function within (and outside of) a nation. In general, *financial* management issues are handled by the *businesses* seeking or creating financial wealth. *Economic* development concerns are generally divided by sector function (e.g. telecom, agriculture, finance, etc.) and handled by specialized branches of the *government* (e.g. telecom regulator, agricultural subsidy board, IRS). *Developmental* issues generally are national in scope and encompass multiple economic agendas; they are therefore often managed by *cross-department government* organizations. These organizations may reside within the nation's borders (Latvian Development Board, based in Riga) or be resident in a foreign country (Colombian Embassy in Washington, D.C., Singapore Tourist Board, located in Hong Kong). Often these developmental institutions serve as links between a nation's policy and commercial goals and as catalysts for the implementation of the dual agendas.

When we speak of strategically managing privatization, we are referring to a range of financial, policy, and managerial activities that support the effective implementation of a privatization. We are speaking about the need to:

- *coordinate government and business activities to* ***solve an internal policy agenda*** *(financial and economic change);*

- *coordinate government and business activities in order to effectively* ***communicate a country's business proposal to the external global investment community*** *(economic and developmental growth).*

While the agenda stimulating the two activities are the same (privatization), the *centers of organizational activity* needed to accomplish the task are different. In other words, by strategically distinguishing the tasks of a privatization on a policy and institutional basis, telecommunications service providers and governments may find that they can be more effective in their privatization marketing, sales and results.

What can managers do to make their privatizations more attractive to outside investors? They can strategically plan and manage the process in a more detailed and investor-focused manner. Privatization is a contentious process; it is expected that bureaucratic in-fighting will occur (indeed, an investor sees some degree of such dialogue as a healthy sign of internal communication processes within a foreign nation). However, legislative bickering, public battles in the press and ongoing judicial processes are not what the investor should have to dissect in order to understand the goals, plans and terms of a privatization auction. Nor are they generally considered positive marketing procedures for soliciting foreign investors.

At the start (Phase I) of the privatization process, nations should outline their privatization goals and then break them into specific policy and commercial agendas. In many cases, a political leader with a clear mandate for change may organize a privatization board or independent privatization commission; this organization will then be charged with overseeing the privatization process. The political leader (or the empowered organization) should then assign each phase and activity of a privatization to the most appropriate national institution suited to coordinating the task (which in some cases, may be the empowered organization itself).[v] The privatization process should not just be organized in terms of phases within a timeline, but each task of the process should be linked to its policy or commercial goal and as is appropriate, delegated to a center of organizational activity best suited to soliciting debate and coordinating and managing the implementation of the task.[vi] Institutional and individual stakeholders within each activity should similarly be identified in order that appropriate representation can occur as issues are debated and decisions are taken.

This is not to state that all issues will easily divide between players and organizations; we believe the situation is quite the contrary. Almost all issues will divide and sub-divide and require the input of multiple organizations and players. But by delegating responsibility for sub-components of the process to specific institutions, the ability to adhere to a privatization timeline, complete all the tasks, and eventually select and negotiate the close of a sale can be greatly enhanced. It is further suggested that if possible, that each institution have representation at the debating level -- the working level -- and have authority to assist some aspect of the privatization process at the managerial level within each working group.

How might we diagram such a strategic process? As noted earlier, government planners are challenged to handle two tasks during a privatization. They must solve dense and complex sector restructuring and planning issues (the internal policy agenda) while at the same time, publicly market their country as an attractive investment opportunity. In order to help government planners separate the activities and think as managers and as teammembers (or, in a strategic sense, internationally as well as nationally), we turn to a strategic planning investment model[vii] which we believe is applicable to a nation (developing or otherwise) which is attempting to manage and market a privatization in the competitive global business environment.

Managing and Marketing a Privatization: Thinking Like A Global Investor

One of the preliminary methods an investor utilizes to distinguish how for example, India differs from China is by analyzing and comparing four groups of reasonably visible and distinct country factors: a country's economics, politics, demographics and its culture. (Individuals interested in learning more about the specific components of the model are strongly encouraged to read the author's full description[viii] and companion volume; the discussion that follows is a brief summary of key points of Austin's model.) Using a variety of sophisticated and sometimes surprisingly simple techniques, business persons rank aspects of each country's factors in order to assess the relative attractiveness of a country investment. For example, if Rwanda is having a war or Peru is in economic crisis, it is hard to justify pursuing an investment in an entity which may be privatizing within those nations. If Mexico is implementing economic reforms and there is a surplus of trained software engineers, the timing may be right for an investment in Telmex.

For this reason, it is important that if an entity (e.g. the telecommunications service provider) within a country is considering privatization, that representatives of the privatizing entity begin to dialogue with representatives of the government with both national (policy) and developmental (national/international) interests. While this action may appear obvious, the strategic imperative for doing so may not be. It can take as much as 24 months to prepare for a privatization and 20 months to implement; assuming the country is courting international investment, it is important that during that time period that appropriate public relations and policy messages are crafted and distributed by the country on a national and international basis[ix]. While we do not imply that healthy dialogues should be stifled or kept from the public, it is important that as contentious privatization issues are discussed and debated *within* a nation, that only a *selected amount of that discussion* be communicated to the outside community. Managing a privatization is stressful enough, one does not need the additional task of managing the global public's response to a country's internal debates.

And how exactly are those messages sent? How does a telecommunications service provider sail through Miller's six stages of privatization success?

After a preliminary review of a country's four factors, investors generally monitor and evaluate four aspects of a country's international relationships. Countries interact daily through a variety of mechanisms. They trade, they invest in each other and often organize coalitions and/or relationships on a bi-lateral or regional basis. Often they join international forums in order to craft treaties or resolve issues with global impact. These activities are identified within Austin's model as a country's international environment and are more specifically noted as market transactions, global industries, bilateral linkages and multilateral mechanisms.

In the case of privatization, a potential investor may turn to the nation's foreign embassy to get economic or political information; they may monitor a nation's voting record at the UN or loans at a multilateral bank, trading agreements or recent changes in importing tax guidelines. A telecommunications manager worrying about how tariff rates may be set when a sector is opened to competition may not concern themselves with their nation's voting records or taxation codes, but to the foreign investor, the linkage is critical. *Each center of organizational activity within each layer of the nation's institutional environment is sending a message about that nation to the investing public.* They are showing the potential investor the realities of what it will be like to work within the country's business and commercial environment, should the investor choose to buy.

Each national institution and center of organizational activity which is conducting business must realize that in today's environment, its actions can and probably are being communicated to the international community on a daily basis. Stressful as it may be on an internal basis, a nation's internationally-focused government and business institutions must be viewed as strategic allies to the telecommunications service provider's efforts to privatize. Indeed, these groups may present natural and effective communication mechanisms for the country's privatization business proposal to the external global investment community. International messages should be consistent and portray an attractive investment environment if the country desires quality investors at the bidding table.

In business, we often speak of the role of the HCG or host country government. Perhaps a more appropriate way to speak of this powerful entity is to recognize them for their role as the shapers and implementers of national strategy. As strategists, governments communicate their messages through policies (investment laws, wage rates, tariff structures, repatriation restrictions, etc.). Policies are then implemented through various instruments (legal and administrative mechanisms) and institutions (commissions, regulatory boards). In telecommunications, the regulator wields power over the sector, determining who will conduct business and how. For that reason, we have identified the ***telecommunications regulator*** as its own entity for analysis within the government environment.

How does the "government" fit within the privatization process? They harbor a dual agenda. As shapers of national policy, the are responsible for drafting the laws and guidelines that will allow the desired sector restructuring and/or privatization to take place. Similarly, they are also the conduit between the country's business/financial growth interests (telecommunications service provider) and its developmental (international) spokespiece. As the telecommunications service provider shapes its business vision and privatization plan, it is the government that will support that vision through changes in national plans and policies. And it is the regulator and government organizations charged with economic development (Ministry of Communications, Trade or Finance for example) who will work with related cross-department government organizations to turn that message into a developmental strategy that will be communicated (positively) to the international public[illegible].

So far, we have spoken little about the organization that in our view, bears the hardest task during a privatization.

The *industry* level is the one most familiar to business persons. In this sphere, we consider the *composition* of the telecommunications sector; that is, the telecommunications service provider, manufacturers, competitors, potential new entrants, industry associations, trading groups, lawyers, consultants, etc.

When we review N. Miller's privatization outline, it becomes evident that a large burden of the privatization task falls upon the entity being privatized. Indeed, a quick review of the six privatization phases shows that during a privatization, the majority of the task's responsibilities primarily rest with the telecommunications service provider (see Attachment I).

As has been discussed, the important privatization challenge is not just "getting organized" as identified above; rather it is designating an independent team or board to manage the process and then ensuring that appropriate tasks are delegated to the appropriate centers of organizational activity within the country. New telecommunications sector goals must be put in place. Bidders must be located while the telecommunications service provider is analyzed, scrutinized, valued, and in some cases sanitized. "Discussions" take place with labor unions and with the public. As the goal is to raise government revenues or create a business environment where future government outlays can be reduced, consultants, planners, advisors, etc., and members of the enterprise work closely, preparing the telecommunications service provider for the closing. And when all goes well, the telecommunications service provider is privatized, the ownership transition takes place and the sector operates under new regulatory guidelines.

But what about our investors? Have they bought in?

Generally, there are two types of investors in a telecommunications service provider's privatization: operating companies and market equity investors (see Attachment II).

Operating companies invest because they are in the telecommunications business and hopefully understand how to make a profit. They recognize that when run properly, telecommunications networks generate positive returns. They therefore believe in (a) the country's potential to reform and/or restructure its telecommunications sector and (b) under the right business/government conditions, the potential profitability of the telecommunications service provider being privatized.

Market equity investors are gamblers. Their horizon tends to be shorter-term as they look to pocket the gains of an enterprise that has traditionally been badly managed and is therefore undervalued. They have little interest in the enterprise's day-to-day management; they expect that the turn-around activities will be managed through (a) the combination of financial infusion, new management and an enterprise's restructuring plan and (b) the foundation of new economic plans and policies that will support a reformed telecommunications sector.

What do both of these players have in common? They are both aggressively monitoring all three aspects of a nation's infrastructure as they evaluate a potential privatization opportunity. The operating company may primarily focus its efforts on evaluating the telecommunications service provider and the telecommunications sector; however, they will invest time at the national or policy level, for they know that no telecommunications sector can host a fair game if a well-functioning telecommunications regulator is not in place.

The market equity investor may focus its efforts primarily at the national and international levels. They are concerned with the reform policies that can allow for sector change and the secure and profitable investment of their funds. They also want to ensure that they can access their investments at any point in the future so that they can strategically invest elsewhere. Therefore, the country's international relationships (currency trading and related international investment issues) can become paramount. Of course, they are gambling on a turn-around operation so they will evaluate the enterprise's financial condition, relative "under-valuedness" and its growth opportunities, potential competition, etc.

When considering a privatization bid, investors will monitor multiple aspects of a nation's activity in order to assess an investment's attractiveness. Beginning with a review of the country's overall environment, analysts will delve deeply into the relationships and inter-relationships between the sector, national (including the regulator) and international centers of organizational activity within the country. They will evaluate numerous research statistics and parameters, and monitor the effectiveness of the institutional environment. After having done so, they will make a decision regarding the attractiveness (or opportunity cost) of one privatization opportunity versus another.

Privatization Snapshots: A Brief Look at Malaysia's and Singapore's Privatization Strategies and Implementation Plans

In the 1980's, driven by the need to turn the private sector into the engine of economic growth, the Malaysian government decided to transfer a number of government-run activities to private ownership. It was noted that "the approach to privatization in the telecommunications sector in Malaysia has been lengthy and deliberate" as the thrust of the privatization had been to accord the operator more operational autonomy and independence to finance its operations. Because national goals did not necessarily "focus on reducing foreign debt or to inspire confidence for those who would invest directly in the economy"[xi], minimal attention was paid to foreign investors. "Rather, the government's objective has been to widen and deepen the liquidity of the Malaysian capital market through the flotation of Telekom Malaysia's shares."[xii]

Subsequently, the Malaysian government's efforts focused its strategic privatization activities at the *financial (industry)* and *economic (developmental)* levels. Telecommunications legislation was amended to allow the government's telecommunications department, Jabatan Telekom Malaysia to be transformed into a corporation (Syarikat Telekom Malaysia Berhad (STM) or more informally, Telekom Malaysia). The 1980 Pensions Act was modified to enable pensionable civil servants to be transferred to the private sector without loss of rights; the Malaysian Constitution was altered to allow the disposal of state land and assets to a private company. Numerous internal changes occurred within the telecommunications operators to encourage a more profitable and market-oriented business. Lastly, as responsibility for telecommunications operations shifted to STM, the government's regulatory activities were reorganized. While STM was issued a license to operate the network for twenty years from 1987, licenses were given to other companies to operate mobile, public pay phone and paging services in competition with STM.

On the financial side, in November, 1990, the government offered a block of approximately 23 percent of Telekom Malaysia's shares on the basis of a *private placement* to various Malaysian institutions. Of the 470,000 shares offered by the government, 70,000 were reserved for employees and managers of Telekom Malaysia. Moreover, as part of an indigenous development policy, 100,000 shares were reserved for Bumiputera institutions. Another 152,000 shares were reserved for "designated institutions" -- financial institutions and pension funds. To date, the government owns 75 percent of STM's stock (valued at over US $5 billion), with foreign investors holding a minimal share of about 15 percent of the privately held stocks. No foreign operator was involved in the privatization of Telekom Malaysia.

In sharp contrast, Singapore's telecommunications privatization has been largely dominated by the concentrated strategy of Singapore Telecom (ST) to become a global player. While privatization would stimulate investment in the nation's telecommunications sector, these activities were viewed on an *international* basis, as one of many competitive countermoves to regional and global competition.

As part of a larger national (international) development strategy, ST's privatization can be seen as a result of *domestic pressures for growth through international market investments*. With ST seeking to enter international markets as a competitor, ST was confronted with demands to loosen its reins on its own market. Because ST developed its network and business in a manner which provided huge cash reserves for investment *(financial or industry issues were not their privatizataion priority)*, their privatization plans were grounded in dialogues that focused more on *national development plans centered in an international context*. They did not need to privatize to stimulate domestic capital markets nor (with 3 million people) do they have a large enough long-term market to offer foreign investors. They needed to privatize in order to advance the company's and country's global outreach.

Subsequently, ST has faced rapid competition in multiple segments of its home market. In an advance response, ST invested heavily overseas since 1989, committing over US $1 billion in at least a dozen countries.[xiii] In 1995, strategic growth activities were announced involving investments and alliances in China ($300 million joint venture and a $29 million paging venture), the 24.5 % equity acquisition of an Australian long-distance voice and data company, links with IBM to provide wireless and related services, the launching of an international pre-paid calling card and the opening of branch offices in Tokyo and Beijing. While privatization has come to ST, the strategic thrust and implementation of that privatization has been directed through *centers of organizational activity* far more focused on *national (developmental)* and *international* concerns, as opposed to more specific *financial* or *industry* conditions (such as those in Malaysia).

To the Future: A Strategic Plan for Action

What can managers do to make their privatizations more attractive to outside investors? They can recognize that their privatization responsibilities are two fold. They must contribute their expertise to help their nation solve an internal policy agenda regarding economic reform. In doing so, their tasks may be specific to sector issues, national policy and planning concerns or to a nation's internationally-focused activities. At the same time, managers may wish to recognize that even if their role seems focused within one sphere of government activity, through their interactions and communication with various centers of organizational activity within their nation, they are ***ongoing*** contributors to the country's strategic privatization sale to the external global investment community.

Because privatization activities encompass multiple agendas, it is vital that the privatization process be managed strategically. One way to ensure that the process does not destroy itself through bureaucratic and legislative in-fighting may be to allocate key tasks to appropriate individuals and institutions, and to create situations whereby government and business representatives have the opportunity to be both working level and managerial members of the multiple-task process. In doing so, it is hoped that issues relating to a potential privatization can be voiced in the appropriate forums where actions may be considered and/or taken. A coordinated process of phased activity between members of the telecommunications sector, the government's planning offices (including the telecommunications regulator) and the nation's international representatives may also help to more effectively manage the process of privatization by uniting resources in a strategic manner. In doing do, key individuals and centers of government/business activity may be able to work together to realize the nation's mutliple objectives: to successfully stimulate economic reform and to allow their nation to become the beneficiary of a profitable international sale at the same time.

ATTACHMENT I

Privatization Task	*Primary Centers of Organizational Activity (particularly important players are identified in **bold**)*
Phase 1: Get Organized	**Sector, National, International**
Phase 2: Define the Specific Goals for Restructuring	**Sector,** National **(Regulator)**
Phase 3: Seek Out the Potential Bidders and Prepare the Company for Sale	**Sector,** National, **International**
Phase 4: Negotiate the precise Terms of Sale with the Successful Bidder	**Sector**, National, International
Phase 5: Prepare and Execute the Closing	**Sector,** National
Phase 6: Implement the Transition to Private Ownership and Operation and New Governmental Oversight and Regulation of the Sector	**Sector, National**

ATTACHMENT II

Telecommunications Reform: Investor Motivations and Strategic Purpose

Who Buys?	Strategic Purpose
Operating Companies - mostly foreign	Gain Global Presence Acquire Controlling Interest Industry Profit Generally, a Long-Term Investment Strategy
Market Equity Investors - domestic - foreign - Banks, Individuals, Institutional Investors	Financial Diversification Emerging Markets = Growth! P/E Ratios: Often Undervalued Telecom: A Proven Industry Success (profits) Generally, a Shorter-Term Investment Strategy

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[i] Cited in "Escaping the Heavy Hand of State", *The Economist*, June 13, 1992, page 73.

[ii] Information provided by Coopers and Lybrand, *Pacific Telecommunications Conference, 1994.*

[iii] *Privatizing a National Telephone Company -- How Do You Do It?*, N. Miller, Esq, Miller & Holbroke (now Miller, Canfield, Paddock and Stone), Washington, D.C.

[iv] In telecommunications, efficiency goals can include a desire to set better (e.g. higher) prices, separation from losing enterprises (such as postal services) or the shedding of surplus workers.

[v] In some cases, a team of organizations may best be suited to managing a particular task (e.g. tariff pricing or particular conditions of sale may need to be negotiated between the telecommunications service provider, the regulator and members of the national investment board). In these cases, efforts should be taken to develop a well-represented cross-functional team.

[vi] We do not imply that any one organization will be given full decision-making authority for the privatization. We suggest that organizations be designated managers or sub-components of the full task at hand.

[vii] Adapted from *Strategic Management in Developing Countries: Strategic Analysis and Operating Techniques*, James E. Austin, The Free Press, New York, 1990, p.30.

[viii] *Strategic Management in Developing Countries: Strategic Analysis and Operating Techniques*, James E. Austin, The Free Press, New York, 1990. *Strategic Management in Developing Countries: Case Studies*, J.E. Austin with T. O. Kohn, The Free Press, New York, 1990.

[ix] Since investors will scrutinize the appropriateness of an investment in any nation, in our view, no amount of public relations or "quick policy fixes" can counter the known realities of a country's situation when it is experiencing difficult or turbulent times.

[x] Again, the process is not necessarily linear. In most cases, a team of organizations or a "privatization board" may work together to ensure that consistent messages communicate between all players within and outside the country. Our point is not that tasks must be "handed-off"; rather it is the importance of all centers of organizational activity consciously working an internal and external agenda throughout all stages of the privatization process.

[xi] R. Bruce and J. Cunard, *Restructuring the Telecommunications Sector in Asia: An Overview of Approaches and Options*. Reprinted in . *Implementing Reforms in the Telecommunications Sector: Lessons from Experience* edited by B. Wellenius and P. Stern, World Bank, 1994, pages 197 - 231.

[xii] Ibid, p. 209.

[xiii] The UK, Norway, Sweden, the Philippines, Thailand, Vietnam, Cambodia, Sri Lanka, Indonesia, Australia, Hong Kong and Malaysia to name a few.

Reforms in the Indian Telecom Sector

T. H. Chowdary, Director
Center for Telecom Management and Studies
Hyderabad, India

The unique features of deregulation of India's telecoms, the extent of competition, the fantabulous high license fees quoted by bidders likely to militate against extended affordability and the status of operating licenses and service deployment are described in this paper.

1. One of the most unique reforms of the telecommunications sector anywhere in the world is going on in India. The colonial times Indian Telegraph ACT (ITA) of 1885 and the post-independence (1947) India's resolution to have a socialistic pattern of society combined to vest exclusive privilege and right to establish telecommunications, solely in the government. The Department of Telecoms (DOT) of the Government of India (GOI) assumed responsibility and exclusive authority for the manufacture of equipment, including R&D; investment in, ownership and provision of network and services; formulation of policy; licensing and regulation which consisted of fixing up prices and arbitrating upon disputes between itself and customers, by itself.

Because of contending requirements for investments funds by other sector like water supply, health, literacy, electricity and poverty alleviation, DOT could not expand and improve the network as fast as demands grew. The easiest way of generating investment funds was to increase prices, almost every alternate year, far above costs and using the surplus for investment. The two undesirable consequences were: (a) the telephone price index (TPI) rising faster than the general price index, and (b) the period as well as the waiting lists for telephones increasing year after, despite more telephones being given in any year than in the previous year. Measures to depress demand by imposing periodically higher deposits along with wait-listed applications temporarily pushed down demand but did not eliminate it. The waiters used to be between 30% to 50% of those who have phones and amounted to 2.5 millions in 1995. The telecom situation was characterized by:

- Inadequate availability of every type of telephone equipment produced in India.
- Growing waiting lists.
- Non-availability of variety of services like mobile phones, radio paging, data, Fax, conferencing, E-mail, EDT, etc.
- Poor quality of service.
- Rising telecom prices.
- Customer vexation and dissatisfaction and all these despite the 120-fold increase in the 80,000 telephones in 1947 to 10.0 million in 1995. The network has modernity also; optical fiber and microwave and satellite transmission; electronic digital switches, direct distance dialing, itemized billing, etc., most of them in the last decade.

2. The mounting dissatisfaction induced rethinking in the decade-long position of "state alone" in telecoms. Manufacture of equipments and cables as well as R&D was demonopolised from the latter half of the 1980s. The results were remarkable. US$350M of private sector investment went into manufacturing within eight years, compared to monopoly state investment of US$140M in 47 years. More than 80 companies sprang up and competition lead to:

i) fall in prices by 25% to 75%

ii) abundant supplies freedom to stage strikes at will with impunity and the prestige of government

iii) quicker deliveries

iv) improved quality and varieties of equipments.

For the first time, non-DOT designed and productionised new series of digital switches from rural to large city applications came to be produced in India. Five trans-nation-set up digital switch manufacturing facilities in India. Competition and that too at global level for equipment production is established in India. Indians invested massively in the new telecom manufacturing companies and every new public issue of telecom shares is oversubscribed.

3. But the paradox of increasing but unmet demand for services coexisting with under-utilization of manufacturing capacity and the availability of abundant investible funds with the public intrigued public policy makers and critics. The DOT is not able to tap the market for funds because it is a government department. Its workers, unions and officers oppose Corporatisation which could enable it to raise equity and debt to finance expansion. Unions oppose the move as it would mean loss of jobs (the DOT is awfully overstaffed with under 20 telephones per employee compared to 180 to 300 elsewhere); loss of assured promotions by seniority, service. Forced Corporatisation would lead to industrial strife. So the only feasible way of bringing massive investment funds into the telecom sector is to extend the demonopolization from manufacture to network and services. That would be an ideological decision. Though vigorously advocated by consumers, economists and non-dogmatic engineers since the late 1980s, it is only in the aftermath of GOI's total retreat from statism since the financial crisis of 1991 (and the collapse of the USSR and sudden loss of respectability of and faith in "Socialism") that private sector entry into telecom network and service provision because a publicly arguable and acceptable proposition.

4. Government first took the decision that all services, other than basic telephone, cleverly termed as value-added, would be provided by private sector companies only and that DOT should concentrate on telephones and their extension to rural areas. Cellular mobile radio telephones, radiopaging, electronic mail, audio- and-video conferencing, trunked private mobile radio, VSAT-based data networks for companies, videotex, voice mail box, etc., are all brought under this category and reserved (for the time being) for private sector companies only.

5. The DOT then (in 1992) initiated the licensing of cellular mobile radio telephone and radio paging licenses, with a notice inviting tenders for eight operators in the four Metro markets (Bombay, Delhi, Madras and Calcutta) for CMRT and 26 cities for radio paging. The conditions imposed were onerous and the selection criteria were not announced before the bids were announced. This led to litigation and licenses were awarded after a 3-year delay. Radio paging services have commenced in a number of cities. Mobile services were delayed for want of frequency assignments but are available since Oct'95. In the second stage, tenders were invited for award of about 40 licenses for radio-paging state-wide. This exercise has also run into trouble, this time because the highest bidder who won licenses for almost all the states, reneged realizing that his bids were for far too excessive a license fee, which was much in excess of the next highest bidder. Retendering is resorted to and licenses would be given by new year 1996.

6. While these new services are all wanted by mostly business users, the bulk of the problem lies with the basic telephone service. At less than 1 telephone for 100 persons, and over 300,000 villages out of over 550,000 still without a phone, 2.5 million applicants still waiting for a phone for years and telephone still unaffordable by bulk of households (the per telephone revenue is about 1.4 times the per capita income in India in contrast to 0.05 in developed countries. That is, telephone is 28 times less affordable in India), national policy must focus on extension and growth of the basic network. Despite obfuscation and opposition from within the DOT, the government has boldly adopted a new National Telecom Policy (NTP) in May 1994. It is historic and unique with the following chief elements.

- Private sector companies will be licensed to construct networks and provide basic telephone service on a state-wide basis. They must have a foreign partner who has operating experience with not less than 500,000 subscribers and who must take a minimum equity of 10% in the joint venture and may have a maximum of 49%.

- The licenses must give a specified proportion (over 10%) of connections in rural areas.

- The net-work must cover all the districts within 24 months.

- The DOT would have monopoly over inter-state telecoms and its public sector company, VSNL would have monopoly over international telecoms, for five years.

- The prices charged by the DOT would be the ceiling for P-Telcos prices to customers. They can charge less.

This means duo-polistic competition between the Government's DOT, the incumbent and a private company in each of the twenty-one service areas. Competition in local services and monopoly in long distance and international has no parallel anywhere in the world. The contrary *i.e.* competition in long distance and monopoly in local services is common. Most of the Indian states are much bigger and more populous than countries in Europe and since intra-state long distance competition is permitted, this situation may not be financially crippling to the state-level P-Telcos. Initially, the share of the local telephone companies for national and international calls has been set at about 50%. There is also the promise that the monopoly of the DOT may be ended sooner than five years, after a review. The DOT's choice of monopoly in interstate and international was buttressed by its need for revenues from these lucrative sectors to provide rural telephones, a dubious argument because such an obligation is imposed on the P-Telcos also.

7. Yet another unique feature is competition between a Government department and private company. The DOT does not pay income tax on its profits, the P-Telcos have to pay. The DOT does not pay license fee but the P-Telcos have to pay. And it is not clear who is the recipient of the license fee. If it is DOT (that is what it thinks), it means that it gets subsidized by its competitor! The P-Telcos have to pay an R&D cess at 1.5% of their sales. If this goes to the DOT (as it expects) then P-Telcos fund the R&D of their rival with no apparent benefit to them! Obviously there can be no level-playing field between the privileged incumbent government department as an operator and the fledgling private companies. These are the aberrations in the telecom demonopolizing reforms in India. These could be lived with in the hope that these would be removed when an independent and autonomous Telecom Regulatory Authority is set up. Another unprecedented feature of Indian telecom reforms is the absence of an independent regulator. The Indian Telegraph Act 1885 could not have thought of independent regulation; it was total control-oriented. Now the DOT as an operator is indistinguishable from the Telecom Commission. As a result, the DOT as policy maker, licensor operator and ministry is having to implement the policy of demonopolization and competition. In effect, the incumbent monopoly is laying the terms and conditions in the tender, putting license conditions, selecting its competitors and is also the appellate body for resolving disputes and disagreements between itself and the licenses. There has also been no clarity as to what clearly is the purpose of the reforms:

- Is it to get massive investments into the telecom sector and use them to extend, improve the network and given more telephones?
- It is to maximize the revenues to DOT through hefty license fees?
- Is it to reduce prices and increase affordability, through the instrument of competition?
- Is it to enhance customer choice, control and to give him varieties of services?

Because of lack of clarity and the globally induced urgency of reforms, a pragmatic approach of learning and grappling with the issues is adopted to progress the reforms. This has been held to be totally unsatisfactory by Indian companies and their foreign collaborators as well as independent critics. They have expressed serious concerns at the lack of transparency and objectivity in the licensing conditions and process. Government has promised to constitute an independent 3-man Telecom Regulatory Authority, before the cellular and basic telephone tenders are opened. The former were opened on 7 June and the latter were opened on 23 June 1995, both after repeated postponements. In the meanwhile, union-inspired litigation has questioned the basic tenders in a High Court of one of the States. Some leftist, scientist / engineers and Members of Parliament moved the Supreme Court of India to rule against private sector entry into telecoms on the plea that "privatization" is against the directive principle of socialism in the Constitution. the Supreme Court did not stay the tendering and license awarding process.

8. Government moved an amendment to the Indian Telegraph Act 1995 with the ostensible purpose of constituting the TRA. The Lok Sabha (lower house) passed the Bill but the Rajya Sabha (upper house) where the Government has no majority, did not accept the bill as the amendment is an eyewash because the TRA as contemplated in it would be non-statutory and subordinate to the DOT, which is one of the competing operators. The Minister withdrew the Bill and promised to bring forward a comprehensive bill. Government has so far not constituted the TRA. The telecom

technocracy of the DOT would like to fill up the TRA with its own persons and if this happens, the entire licensing and regulation would be a farce and would imperil the health of the P-Telcos. There would be innumerable delays and disputes between the operator DOT and P-Telcos, with the allies and colleagues of the former constituting the TRA which then can not do justice or seem to be just. While the non-existence of an independent and statutory TRA may be frightful to foreign companies, Indian companies with the matters experience of having profitably lived with controls, permits licenses, quotas, etc., for four decades are undaunted. They rightly believe that the initial difficulties and disadvantages can be overcome, even retrospectively, by training and teaching to the TRA. While striving for an ideal regime, they would not jeopardize the opportunities. That is why in spite of fears, 32 companies bid for 38 cellular licenses in 19 circles and 16 companies bid for basic telephone licenses.

9. The Unions, with silent sympathy from and encouragement by top officialdom is waging a guerilla opposition against reforms with strikes and writs in judicial courts. The most sober of them concede that demonopolization is natural, competition is desirable and corporatization of the DOT is necessary. But they want to be assured of no loss of jobs; they want to be retrained for new technologies as well as competition. They aver that P-Telcos will wean away most of the business customers, less than 10% of whom pay 70% of DOT's revenues, and then DOT would be left with rent-only paying and low-calling customers; DOT would become sick; unable to compete and then the workers would suffer. Their fears are totally true. DOT has not yet initiated any worth-while measures to retrain their staff and refit them into a competitive enterprise.

10. The challenge or looming competition is having a salutary response in the DOt. They have stepped up the rate of giving new connections 1.7 millions in 1994-95 a four-fold increase in the last 4 years. In 1995-96, they plan to given 2.3 millions connections. Inter-city *i.e.* long distance transmission, is getting congested due to under-investment in that segment. The National Power Grid Corporation, the Indian Railways (who already have 25,000 Km of microwave radio and 5,000 Km of optical fiber cable routes) and the State Electricity Boards want to provide long-distance transmission capacity to be leased to the state-level basic and mobile telephone operators. Although denied now, in less than 5 years envisaged for monopoly for DOT in the interstate business, these entities are sure to form joint ventures with foreign and Indian Telcos to emerge as facility (not service) providers.

11. As of end November 1995, the status of licensing is neither reassuring nor depressing. Government has put a cap of three service areas, both for cellular service, for any one bidder. The cellular licenses, two for a service area, can be given without much controversy or trouble. But in regard to basic telephones, one bidder quoted three to five times that of the next highest bidder for license fees and was poised to get licenses in as many as nine circles. The amount quoted (about US$30 billion, over 15 years, for territories having half of the population of India) appears fantabulous, constituting about 30% of the gross per line revenue. For the other half of India, the license fee quoted by the highest bidders amounts to US$5 billion! The cap of 3 licenses per bidder is seen as a bailing out decision in favor of a company that put "unrealistic" bids. As though convinced that the license fees of that company are realistic, the DOT rejected the highest bids in ten service areas as being too low. It did not set any reserve amount in the first instance. It is hoped that these issues would all be resolved amicably and that operating licenses for basic telephone services would be issued by January 1996.

12. What, however, is most disconcerting is the high license fees of US$33 billion. The amount is in contrast to the total assets of the DOT, of about US$12 billion and revenues of US$3.5 billion. Many commentators hold that the criterion of the highest license is wrong as the licenses fees would constitute about 25% to 30% of per telephone per year revenues and forming a price element, would go contrary to the NTP's objective of universal service at AFFORDABLE price. Also, it is only the customers of the P-Telcos who have the license fee element in the price for telephone service; the DOT's subscribers do not have this element as DOT, being a government department, pays neither license fees nor income tax. This deliberate discrimination against one set of citizens as against others appears illegal also. The third flow in the license fee is that it amounts to P-Telcos subsidizing their rival, the Government's DOT. That would be unfair competition and is likely to be challenged (as

in Italy and Belgium) successfully before the TRA or Courts. Some even aver that the P-Telcos would co-opt the political bosses and prevail upon them to raise the DOT's rates and charges to such levels that the P-Telcos following suit, under that ceiling, could make profits despite hefty license fees. This has already happened in respect of airlines which after deregulation saw the entry of eight private operators in competition to the former state-owned monopoly, the Indian Air Lines Corporation. Consumer bodies and independent analysts are hoping that they would be able to persuade the TRA to waive the license fee in return for countervailing price reductions.

13. On the whole, the Indian telecoms are undergoing extraordinary structural changes, even ahead of the E.E.C. countries. As technology and competition hold down telephone prices or even reduce them, more and more would be able to afford phone service, putting the network to many uses other than telephony. With the economic liberalization, 1994-95 saw a 5.5% GDP growth (it never exceeded 3%). Soon, we would see growth rates of 8% to 10%. To reach the 1995, the world average in the next 15 years, India would have to add 7.5 million phones a year! That would not be impossible, considering that DOT alone stepped up the rate from 0.4 m to 1.7 m in 4 years. We would now have 15 more companies to do the job. And, if cellular can bring prices into the range of wire-lines, no region or rural or unaccessible area would remain untelephoned. The coalition of all the P-Telcos would be a formidable force to fashion a proper Regulatory Authority as well as a modern telecom law that recognizes the convergence of telecoms, computers and broadcasting, and fits India to be part of the global information infrastructure.

14. In conclusion, the emerging telecom regime in India could be summed up as:

- End of DOT's monopoly in basic telephony within the boundaries of a State / circle (21 such areas).

- There would be one private telephony company competing with the DOT in every state.

- The DOT would have monopoly in interstate and international telecoms, for some time.

- The DOT is not allowed to offer any value-added services including value-added services including cellular mobile radio telephones radiopaging, trunked private mobil radio, VSAT based private data networks, E-Mail, EDI, etc.

- There would be at least two private sector (only) companies competitively providing mobile phones, and radio paging.

- There is no limit on the number of companies to be licensed to provide E-Mail, store and forward FAX, trunked radio, etc.

- There is no independent Telecom Regulator now; the policy-maker, operator and license giving DOT itself is selecting its rivals and setting the terms and conditions (almost always in its own favor).

- Vigorous competition has emerged in all sectors of telecom — networks and services.

- The hefty license fees issue is worrisome to customers, policy makers and independent analysts desiring public good.

- The deregulation of equipment manufacturing industry has let to the emergence of over 80 robust private sector companies making every type of equipment in abundance and yet falling prices.

- The hope is that by 1997 there would be an end to telephone poverty and Indian telephones would grow at about 20% per annum.

- The growth of PCs at one million a year from 1997 would spur the introduction of new services on and new uses of the telecom network like teleshopping, tele-banking, tele-librarying, and multi-media services.

How Competition will Change Management Strategies of Telecommunications Operators

Philip Parker[1], Michael Kelly[2] and Stephen Hains[3]
Arthur D Little
Sydney, Australia

1. Abstract

Telecommunications operators are facing increasing competition in most developed and fast developing countries in the Asia Pacific region. The new competition is quickly eroding tariffs and customer loyalty in the telco's traditional switching and transmission product ranges. In response, telcos have almost universally declared their intention to move into higher value added, more customised services. To meet that objective, they will have to transform their management strategies. Few telcos are fully addressing all of the issues necessary:

- Drive down the cost of basic, non-value added, service provision
- Dramatically improve the pace and quality of new service development
- Sell new and value added services
- Improve customer retention.

2. Provide Framework for Telecom Service Delivery

To explain the concepts of this paper, we use our rocket model of telecommunications service delivery shown in Figure 1, which enhances the often used value chain model.

The modules in the model are defined as follows:

- **Basic switching and transmission networks** include the central office switching and PDH and SDH transmission networks of the PSTN and cellular networks. They also include packet switching, frame relay, and leased line networks.

- **Access networks** include the copper pair local access network, the base stations of cellular networks, and optical fibre and other high bandwidth access technologies where these extend to the customer's premises.

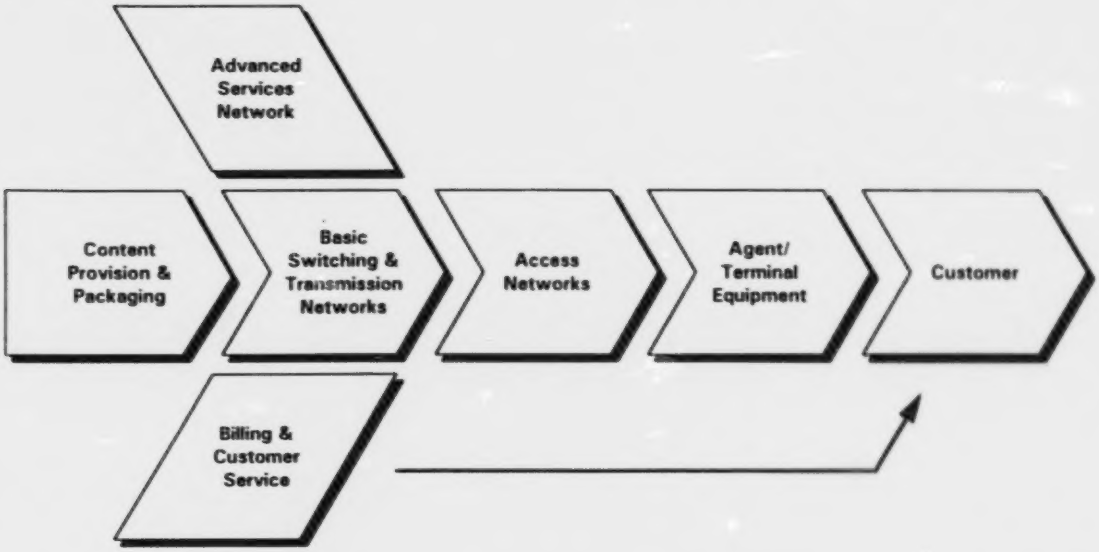
- **Terminal equipment/intelligent software agent** includes the traditional customer premises equipment of telephones, fax machines, PBX's and cellular telephones. It also increasingly includes intelligent software that enables the user to run and manage his on-line applications. For example, for a user accessing the Internet, the intelligent agent could be network browser software, while for a cellular phone user it could be a function key which allows toggling between two numbers (eg. work and personal) for dialling calls.

- **Advanced services network** includes the capability for offering intelligent network services such as 1-800 services, centrex (if implemented in an overlay network), calling card services and on-line transaction verification.

- **Content provision & packaging** includes several sub-functions for the creation, provisioning and packaging of content that is accessed by users. The content may include on-line databases, content available over the Internet, video programs and audio programs.

- **Billing and Customer Service** cover the billing of customers for the services they use and the telephone enquiry customer service. This module attaches to the basic switching and transmission networks module because call data records for billing are downloaded from the switches to the billing system. Also, links from the network management system to customer service are critical for effectively informing customers about network status, perhaps even pro-actively.

Figure 1 Rocket Model of Telecommunications Service Delivery


Advanced Services Network
Content Provision & Packaging
Basic Switching & Transmission Networks
Access Networks
Agent/ Terminal Equipment
Customer
Billing & Customer Service

3. Drive Down the Cost of Basic Service Provision

We define basic service provision as all services provided by only the basic switching and transmission networks, the access networks, and the billing and customer service systems. They include Plain Old Telephone Service (POTS), cellular service, frame relay, packet switching and leased lines.

Competition has quickly eroded tariffs in basic services. This was first evident in long distance and international services, but with the advent of cable telephony and PCS will also occur in local telephone service. Customers are increasingly buying these services on price, and are showing increasing propensity for changing telcos to get the best price.

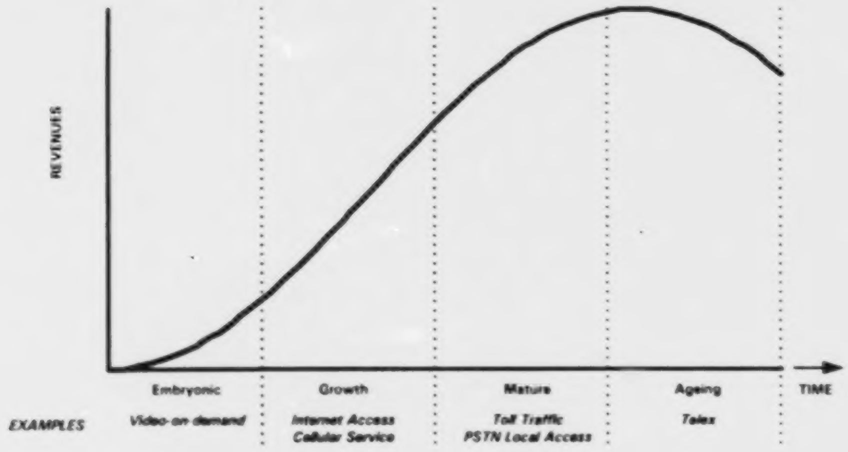
Telcos have been forced to cut costs relentlessly on these services. Whereas a few years ago world's best practice was approximately 250 lines per employee, we have encountered one exceptional example, the Thai start up TelecomAsia, that is aiming to achieve 1000 lines per employee in the next two years. It is achieving this goal by installing a state-of-the-art network, awarding turnkey contracts for detailed network design and network installation, and outsourcing many functions including much of its IT systems installation, integration and maintenance. The goal is more critical, and perhaps easier to attain, because TelecomAsia is confined primarily to basic service provision, rather than customised, value added services, and operates in only a single city, Bangkok.

The fact that a start-up is achieving four times the labour productivity of major established telcos, must send a strong signal that high operating efficiency is a fast moving target, and that there will be severe labour downsizing in existing telcos over the coming years.

4. Improve Service Creation

Telecommunications services, like manufactured products, have a product life cycle. A new service goes through an initial slow acceptance or an embryonic phase, then a rapid growth phase, followed by a high volume low growth mature phase and finally an ageing phase, when sales volume declines. For example in developed countries near video-on-demand is an embryonic service, Internet access and cellular service are growth services, toll traffic and PSTN local access are mature services and telex is an ageing service, Figure 2.

Figure 2 **Telecommunications Services Pass Through a Product Life Cycle**



With increasing competition and service innovation, the product life cycle for many services is shortening. For example, telex had a product lifetime of several decades before ageing. Packet switching may reach a life of two decades before frame relay and faster services substantially take over its market. CT-2, even in the markets in which it has been successful, will be overtaken by low priced cellular and PCS within the next few years.

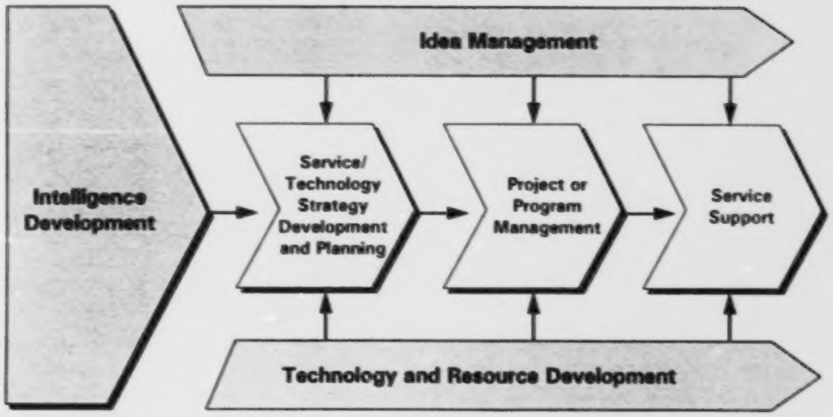
As a result of shortening product lifetimes and increased competition in standard products, it is more important than ever for telcos to increase the rate of service innovation and new service introduction. The objective is to have a large portfolio of products in the growth phase.

The major challenge for telcos in developing new services is to re-align their emphasis from technology solutions to addressing users' applications. For example, narrow-band ISDN was a technology aimed at no particular clear user application and no target market. Consequently, the service has usually not been positioned nor priced to attract users despite its superiority to other data access technologies. Similarly, NTT's plans for an FTTH/B-ISDN nationwide network in the early 21st century are driven more by technological vision than by specific user applications, and could suffer ISDN's fate. On the other hand, providing Internet access is a user application that can be supported by a range of network technology options, including dial-up modem access, leased high speed lines and ISDN. By concentrating on users' needs, operators can refine both the service delivery mechanisms and the pricing to match the users' expectations and perceived value.

Internet access illustrates another point about new telecommunications services. In the rocket model, Internet access is provided through the Advanced Services Network (for the service provider's node), the Software Agent (network browsers), Content Provision (the Internet) and billing. Most new applications oriented services involve each of these four modules. However, no single vendor can provide the equipment or software for all modules. Therefore, the telco must become a systems integrator to present a seamless service to the customer.

Our model of the service and product creation process, Figure 3, was generated initially for the manufacturing industry, but is equally applicable to telecommunications services. In this model Intelligence Development and Idea Management are the prime drivers of new service creation. *Intelligence Development* is the process of understanding customer demands and competitor offerings. *Idea Management* refers to a structured process for generating and evaluating new ideas, funding pre-cursor projects and enabling selected ideas to be explored and validated before ideas become embedded in the company's product and technology strategies and plans.

Figure 3 The Processes in Product Creation


Idea Management
Intelligence Development
Service/ Technology Strategy Development and Planning
Project or Program Management
Service Support
Technology and Resource Development

Top notch service creation requires unique skills, capabilities and competencies within the telco and within suppliers — in short, superb resources. *Technology and Resource Development*, is, therefore, one of the key enabling processes in new service creation. For example, a cellular operator wanting to offer "guaranteed no dropped call" service to its premier customers would need switch and base station vendors to provide the capability to enable the service.

Service and Technology Strategy Development and planning, another key process in service creation, describes where, how, and with what frequency the company intends to compete with new services. This process helps the company ensure that the pipeline is full of new growth products that provide the future profit and revenues for the company.

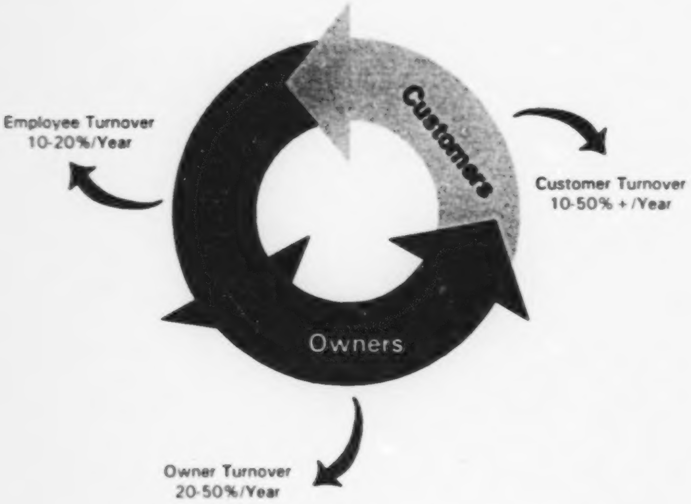
Service Support is the often forgotten last process in product creation, the process that ensures a customer can be reached and can provide feedback. For example, at Telstra MobileNet, Marketing was introducing new service packages that could not be supported with the company's billing and customer service systems. The result was a blow-out in the number of complaints and enquiries arising from new products. Customer Service implemented a process where Marketing had to involve customer service and planning in products to ensure that they could be supported after release.

In fact, customer service for cellular networks has become a major problem. On some cellular networks customers generate in excess of eight calls per customer per year, leading to operating expenses higher than for any other part of the operations. Interestingly, more than half of these enquiries are about billing, and not inherently about cellular services. Instead, the enquiries arise because of the many complex billing plans developed in the competitive cellular industry. As competition also rises in the fixed telecommunications, and service offerings become more complex, we expect that customer service will become a major problem for the fixed network carriers as well.

5. Improved Customer Management and Customer Retention

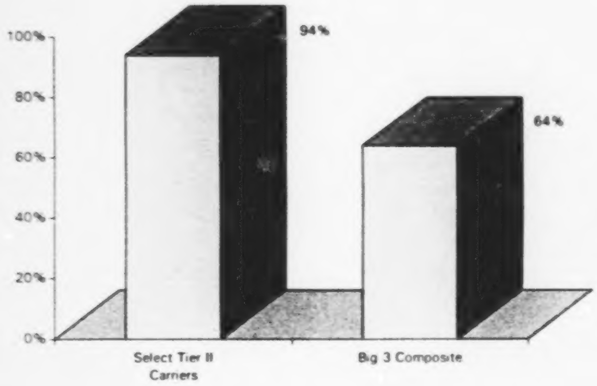
In competitive telecommunications markets, churn can increase dramatically. Figure 4 shows that although most operators think primarily of customer churn, turnover in the US telecommunications industry is high also for employees and owners. Unless properly managed any one of these high churn rates can ruin a good business.

Figure 4 **Churn Rates in United States Telecommunications Industry**



We calculated that for AT&T, the net present value of a five percentage point reduction in customer churn would be US$220 million for paging, US$1000 million for cellular and US$1260 million for consumer long distance service. It is possible to reduce churn and increase customer retention. For high performing second tier inter-exchange carriers in the United States, customer retention is significantly better than for the big three carriers, as shown in Figure 5.

Figure 5 **Customer Retention Rates for Inter-exchange Carriers in the United States**



Obviously, it is more difficult for larger carriers than for smaller carriers to retain customers. For example, it is easier for a smaller carrier to give its customers a more personal service. However, most larger carriers have not made a concerted effort to retain customers. An integrated customer retention strategy would address all aspects of acquiring and retaining customers as shown in Figure 6:

- Acquiring new customers
- Supporting existing customers
- Building customer loyalty.

Figure 6 Integrated Strategy for Improving Customer Management

Approach	Objective	Key Components
Acquiring New Customers	Profitably attract and acquire new customers	Educating potential customers Build brand awareness Alternate channel strategies Channel management Needs-based segmentation Expected customer profitability
Supporting Customers	Efficiently provide service to existing and potential customers	Demand forecasting Customer support systems Work force management Process engineering Call center architecture Service level planning
Building Customer Loyalty	Effectively develop relationships with their customers that remain profitable over time	Integrated marketing database Augmented needs-based segmentation Customer contact profiles Win back programs Targeted promotions Personalized outreach Actual customer profitability

6. The Way Forward

In driving down the cost of basic service provision, improving the cost of new service development and raising customer retention, a telco radically changes its approach to business. The telco becomes leaner and potentially more innovative and more customer focussed. To offer the higher value services requires that a telco can understand and shape its customers' needs and desires, and then sustain a long term relationship with customers despite fierce competition.

In developed countries twenty years ago, the engineering group in the organisation had pride of place as networks were being quickly expanded. In developing countries, this is still the case. Telcos in developed countries have now moved to organisations which are strongly oriented to acquire new customers. In Asia, with its emerging competitive telecommunications environment, telcos are moving in the same direction. Thus, in both developed and developing countries, customer service and new service creation will soon dominate telecommunications organisations, and technology will be acquired and processes realigned to support this trend.

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[1] Senior Manager, Arthur D Little, Level 38, Governor Phillip Tower, 1 Farrer Place, Sydney 2000, Australia, Phone +612 247 9955, Fax +612 2473985, Internet parker.philip@adlittle.com

[2] Associate Director, Arthur D Little, The Gateway, East Tower #13.06, 152 Beach Road, Singapore 0718, Phone +65 297 2300, Fax +65 292 7631, Internet kelly.michael@adlittle.com

[3] Consultant, Arthur D Little, Level 38, Governor Phillip Tower, 1 Farrer Place, Sydney 2000, Australia, Phone +612 247 9955, Fax +612 2473985, Internet hains.stephen@adlittle.com

Toward a Global Network:
The Evolution of Wide Area Networking in Rohm and Haas Company's Asia-Pacific Region

Author: Lawrence H. Ostroff
Rohm and Haas Company
Philadelphia, Pennsylvania USA

1. ABSTRACT

Rohm and Haas Company, a US $3.5 billion global speciality chemical manufacturer, is implementing Wide Area Networks (WANs) to unify its in-country local area networks and enable reengineering of key business processes. The company's Asia-Pacific region sites have been early adopters of WAN technology due to the need for a high degree of information exchange within Asia-Pacific as well as with business and research centers located elsewhere in the world. We recommend that other companies developing similar networks plan in detail their convergence to standard protocols and systems, work closely with strategic suppliers to understand the pace of future technology and service delivery, and carefully manage the expectations of their users and management.

2. INTRODUCTION

Rohm and Haas Company (R&H), a $3.5 billion US-based global specialty chemical manufacturer, is implementing high speed wide area networks (WANs) to support the activities of its global business. WANs in R&H connect widely distributed local area networks (LANs) and host computers. These WANs are an essential foundation for building the enterprise-wide systems that enable reengineering of key business processes covering manufacturing, distribution, marketing, and research. In particular, WANs are important for R&H's expansion in the Pacific Rim, and Asia-Pacific requirements have driven many of the company's WAN developments.

This paper first outlines the business of Rohm and Haas and the drivers for wide area networking throughout this global company. Second, the evolution of wide area networking specifically in the company's Asia-Pacific region is described--including the requirements that motivated Asia-Pacific to be early adopters of advanced networking and the factors such as cost and technology that paced this evolution. Third, the future of integrated global networking in Rohm and Haas will be defined, along with the issues we anticipate and the benefits expected to accrue. Finally, recommendations to other companies implementing similar networks in Asia-Pacific will be presented.

While a truly global company such as Rohm and Haas would clearly desire to have a single global network as opposed to multiple WANs, we have had to pace the development toward true unity because of resource constraints, limited service availability, software deficiencies, and many other factors. Moreover, in the increasingly collaborative business environment in which we operate, the priority of connections to customers, suppliers, partners, and other stakeholders must often take priority over our internal network developments. Nonetheless, in Asia-Pacific, the remoteness of our sites, the relatively small staff sizes, and the need to be informed of business and research activities all over the world create drivers for network unity that are greater than those elsewhere in the company.

3. ROHM AND HAAS COMPANY

Rohm and Haas is an 87-year-old manufacturer of specialty chemicals and is one of the fastest growing chemical companies in the world. R&H's key expertise is in acrylic polymer design, though about one-third of R&H's sales are non-acrylic specialty chemicals. The company has 12,000 employees and sells into most major industrial and developing nations. Although Asia-Pacific region now comprises under 15% of our global business, Asia-Pacific is an important area of growth. We fully expect Asia-Pacific to become one-third of our global business in the coming years.

Rohm and Haas has a network of nearly 50 manufacturing plants and 16 research laboratories to support the business. Our product distribution network is complex. In some businesses we rely on only one or two plants and research centers for global supply/service, while in others we rely on localized manufacturing and research. Therefore, we have a strong requirement for globally integrated networking that provides the foundation for our business applications and communication systems.

4. OPERATIONAL EXCELLENCE: REENGINEERING, ENABLING SYSTEMS, AND THE SUPPORTING WAN INFRASTRUCTURE

In the past, Rohm and Haas could succeed largely on the basis of the quality, uniqueness, and performance of its products. However, in today's globally competitive marketplace, our technology alone is not sufficient to ensure continued growth and success. An important focus for Rohm and Haas now is on operational excellence that can be achieved through reengineering of business processes. Succeeding in improving our operational excellence will mean measurable improvements in customer satisfaction, on-time delivery, and productivity. The objective underlying these efforts is to become the preferred supplier to our strategic customers.

As noted on the horizontal dimension of Figure 1, we've identified five global business process areas on which we're focusing. The improvement effort in the first three process areas (Order Fulfillment, Manufacturing, and the Money Cycle) is collectively termed "Supply Chain Reengineering." Our corporate targets here specifically are to reduce costs by $75 million by the end of the decade, reduce inventories by one-third, and improve on-time delivery to a uniform 100% worldwide. The goals of the Sales/Marketing and Research process areas are to reduce cycle times for processes that serve customers, improve the quality and value of information provided, and to improve productivity of the associated processes.

The vertical dimension of Figure 1 presents the five classes of software applications that compose the systems enabling the reengineering of business processes in Rohm and Haas. The PRISM manufacturing and JDE financial applications are only AS/400-based systems. Order systems today exist on a variety of platforms (PC, IBM AS/400, and mainframe), and we are moving slowly toward convergence onto a single order system globally. The planning system (Logistics Plus) is today only a mainframe application but we will migrate this functionality to distributed PC-based systems over the next two years. The personal computing and groupware applications are all PC-based with varying degrees of supporting functionality on back-end servers.

There are three important points to make about these enabling software applications:

A. Our global I/T group (450 people worldwide and $100 MM annual budget) is organized primarily along the lines of the five business processes and not the specific software applications. The goal of this organization is to enable us to enhance the efficiency and effectiveness of our business processes through use of these software applications. Note that among the 450 person staff are people specifically supporting the network and desktop infrastructure, and these people are in groups working across all five business processes.

B. The WAN infrastructure serves the software applications, and the development of the WAN infrastructure is determined by the implementation priorities of these software applications.

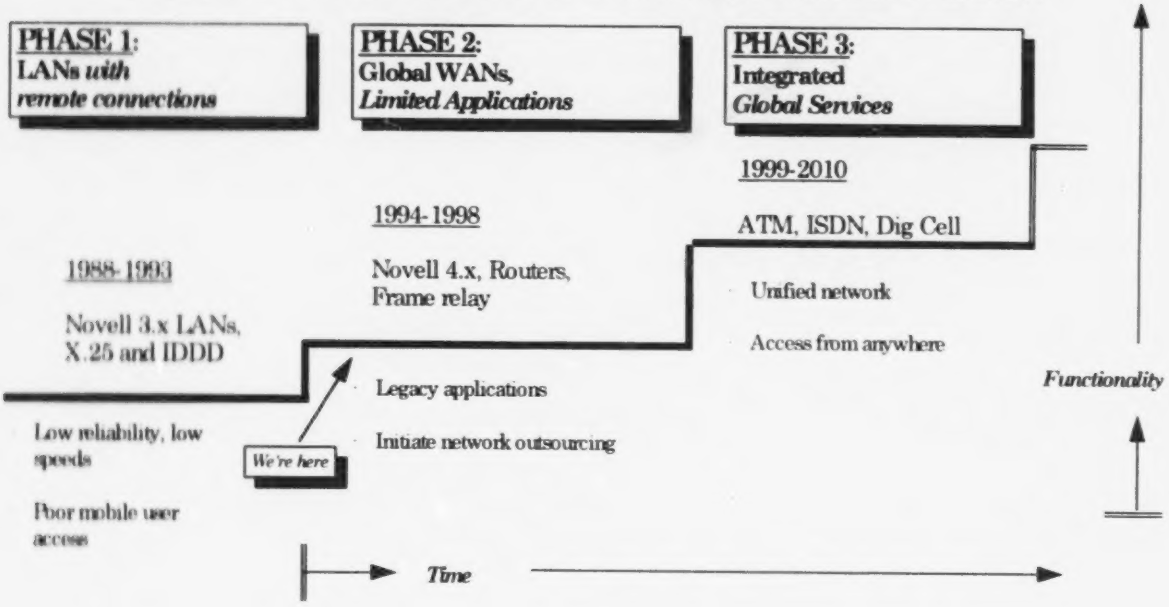
C. The software applications are continually evolving in a direction that is creating increasing demands on the bandwidth and flexibility required of the WAN infrastructure. Specifically, we're migrating toward

o A distributed, object-oriented computing architecture.

FIGURE 1 - REENGINEERING IN ROHM AND HAAS

Business Process IT Enabler	Order Fulfillment	Manu-facturing	Money Cycle (Financial)	Sales/ Marketing	Research
Mfg Systems (PRISM on AS/400)	Available to promise info	Minimize hand-offs	Global financial info	Understand costs	Std product formula data
Order Systems (IBM mainframe PC, AS/400)	Global Inventory Reservation	Fewer schedule changes	Order system integrated w/financials	Better cust service	Improve Sample Delivery
Planning Systems (LogsPlus on mainframe)	Eliminate orders thru planning	Optimize production campaigns	Reduce accounting thru planning	Supply Cust Data for Analysis	Identify Development Opportunities
Personal Computing Applications	Enable individual manipulation of data and creation of documents for reporting, analysis and recommendations				
Groupware and Messaging	Global teamwork facilitated by rapid, low cost communications and rich information sharing				

FIGURE 2 - DEVELOPMENT OF WANs IN ASIA-PACIFIC REGION


PHASE 1:
LANs with remote connections
PHASE 2:
Global WANs, Limited Applications
PHASE 3:
Integrated Global Services
1988-1993
Novell 3.x LANs, X.25 and IDDD
Low reliability, low speeds
Poor mobile user access
We're here
1994-1998
Novell 4.x, Routers, Frame relay
Legacy applications
Initiate network outsourcing
1999-2010
ATM, ISDN, Dig Cell
Unified network
Access from anywhere
Functionality
Time

- o Support for full application sets for mobile users, and
- o Implementation of multi-media applications.

These each generate demands for cost-effective performance and reliability that push the limits of the telecommunications services available globally--and particularly the limits of those services available in Asia-Pacific Region.

5. EVOLUTION OF WANs

The development of WANs in R&H's Asia-Pacific region have undergone the phases identified in Figure 2. Evolution of our WANs has been driven as much by business requirements and desire to contain costs as by target system architecture. In particular, the evolution can be characterised by one that was induced as follows:

Office applications *induced implementation of* PC's: Word processing, spreadsheets, and graphics applications motivated the initial purchases of PC's around the region in the early 1980s.

Global Email and Local Resource Sharing *induced implementation of* LANs: Implementation of cc:Mail coupled with the local desires to share files and printers motivated the initial purchases of LANs beginning in 1988.

Supply Chain Systems and Global Information Sharing *induced implementation of* WANs: Desire for cost-effective, seamless access to order/inventory/production systems around the world as well as our early implementations of Lotus Notes Groupware and Internet applications motivated the implementation of our WANs. This started shortly after LAN implementation in 1989.

6. ELEMENTS OF WANs:

Below is a summary of the elements of our WANs, including supporting hardware, software, and services. Figures 3 and 4 contain an example of key elements of one in-country network implementation (for Rohm and Haas' Japan operations).

Personal Computers: In Asia-Pacific we're consistently using IBM/compatible PC's, and our direction is toward a single PC vendor worldwide. Outside of Asia-Pacific we're investing resources to de-implement many non-standard PC's including the Apple Macintosh.

LAN hardware and software--Toward Ethernet and Novell 4.x: Our network has been built in an evolutionary way from the "PC LAN on up" and thus we don't have perfect consistency among our LANs. We're moving toward Unshielded Twisted Pair wiring (category 5) at all sites around the company. We're using both 10Base-T ethernet and token ring for service at the physical layer to the desktop, though our direction is toward ethernet universally. We are consistently using Novell 3.x for the network operating system, and through 1996 we're migrating to Novell 4.x using internal standards (Novell 4.x provides enterprise services essential to move toward true network unity, such as global network directory services). Outside of Asia-Pacific, we're investing resources to de-implement many non-standard network elements including DEC Pathworks, AppleTalk, and several IBM-based network systems and protocols.

Network Transport Protocol--Toward TCP/IP: Concurrent with our move to Novell 4.x, we'll be installing TCP/IP as our network transport protocol, enabling us to simplify our network through a move from seven to one supported protocols (we're replacing IPX, DecNet, elements of SNA and other protocols with TCP/IP). Also, Internet access can only be provided to PC's which have TCP/IP drivers installed.

Application and Communication Servers--Toward Windows NT: Though we have many IBM OS/2, IBM OS/400, and other operating systems in place, we're moving significantly toward Microsoft Windows NT for these operating system functions. It is conceivable that Windows NT will one day replace Novell as the network operating system in order to minimize software and integration costs.

Global Connectivity--Toward Frame Relay: In Asia-Pacific for inter-country connectivity we're moving from X.25 and IDDD (which have limited performance capabilities) to Frame Relay at a minimum 64 kbps (and a maximum of E1 speeds--about 2 mbps). Elsewhere in Rohm and Haas we have implemented leased lines coupled in some

FIGURE 3 - Japan Network Implementation

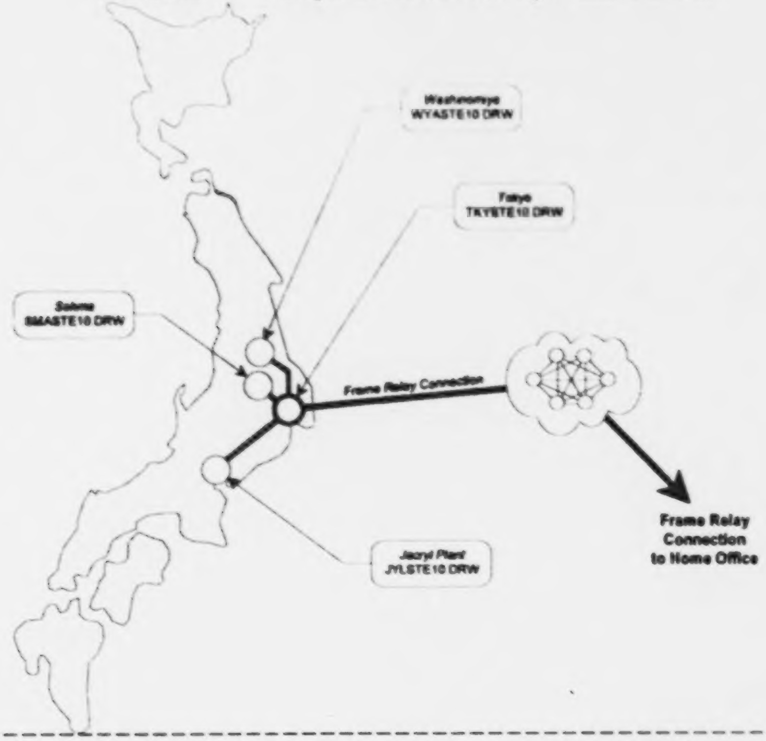
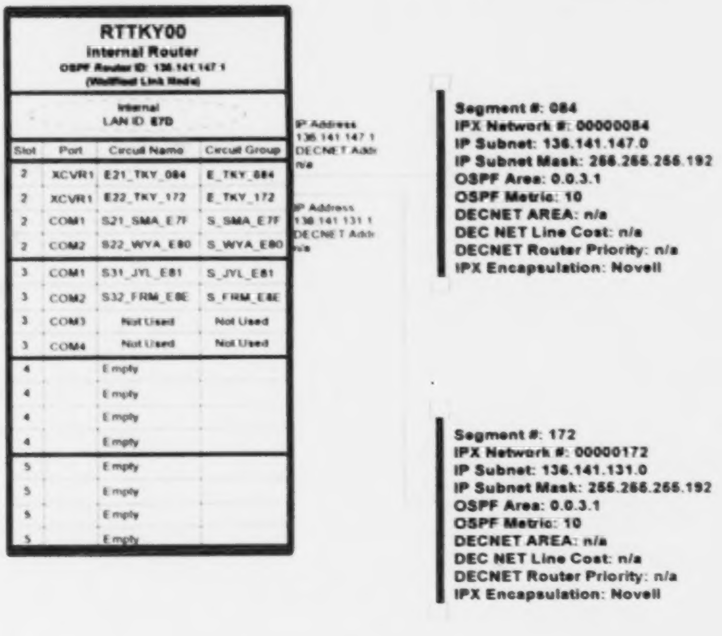

Washnomiya
WYASTE10 DRW
Tokyo
TKYSTE10 DRW
Sohma
SMASTE10 DRW
Frame Relay Connection
Frame Relay Connection to Home Office
Jacryl Plant
JYLSTE10 DRW

FIGURE 4 - Tokyo Router Implementation



RTTKY00
Internal Router
OSPF Router ID: 136.141.147.1
(Modified Link Media)

Internal
LAN ID **E7D**

Slot	Port	Circuit Name	Circuit Group
2	XCVR1	E21_TKY_084	E_TKY_084
2	XCVR1	E22_TKY_172	E_TKY_172
2	COM1	S21_SMA_E7F	S_SMA_E7F
2	COM2	S22_WYA_E80	S_WYA_E80
3	COM1	S31_JYL_E81	S_JYL_E81
3	COM2	S32_FRM_E8E	S_FRM_E8E
3	COM3	Not Used	Not Used
3	COM4	Not Used	Not Used
4		Empty	
4		Empty	
4		Empty	
4		Empty	
5		Empty	
5		Empty	
5		Empty	
5		Empty	

IP Address
136.141.147.1
DECNET Addr
n/a

IP Address
136.141.131.1
DECNET Addr
n/a

Segment #: 084
IPX Network #: 00000084
IP Subnet: 136.141.147.0
IP Subnet Mask: 255.255.255.192
OSPF Area: 0.0.3.1
OSPF Metric: 10
DECNET AREA: n/a
DEC NET Line Cost: n/a
DECNET Router Priority: n/a
IPX Encapsulation: Novell

Segment #: 172
IPX Network #: 00000172
IP Subnet: 136.141.131.0
IP Subnet Mask: 255.255.255.192
OSPF Area: 0.0.3.1
OSPF Metric: 10
DECNET AREA: n/a
DEC NET Line Cost: n/a
DECNET Router Priority: n/a
IPX Encapsulation: Novell

cases with X.25 for global inter-LAN connectivity, but based on our experiences to date in Asia we have chosen to move universally to Frame Relay for inter-country access. The connection of the Frame Relay network to the LANs uses Wellfleet Routers, which are also used for in-country inter-LAN leased line connections. The benefits of Frame Relay include

- o Flexibility: Ability to minimize cost and optimize service
- o Built-in redundancy: This is an added cost for leased lines
- o Natural migration to ATM (asynchronous transfer mode). In particular, our existing Wellfleet routers support ATM, and as necessary we can wrap Frame Relay packets in ATM.

Cross-platform Data Access: We're evolving from function specific LAN-based gateways (i.e., for AS/400 "5250" emulation and IBM mainframe "3270" emulation) toward end-to-end emulation services which take advantage of our high speed Frame Relay inter-country and leased line in-country networks. The same PC-based emulation software (product name is Rumba) can be used to emulate local, in-country and distant AS/400 and mainframe hosts. We're also using a product from SyBase called MDI Gateway to enable transport of data extracted from AS/400 and mainframe hosts to client-server database systems. Any PC application such as Access, Powerbuilder, Visual Basic, etc. that has ODBC connectivity can be used to access mainframe or AS/400 data using this MDI Gateway.

Internet Access: We currently have a single Internet connection to our network in Philadelphia. Our service provider is Global Enterprise Services (GES) from Princeton, NJ, and the GES connection provides us access to WWW, SMTP Mail, Telnet, USENET, Gopher, and any other Internet service. The current access speed is T1 (1.5 mbps) through which all 64 kbps+ connected sites can access these Internet services.

We have ten World Wide Web servers that can be accessed through the internal Rohm and Haas network. Eight of these are Unix-based (IBM Risc 6000 and Sun servers) running NCSA's HTTPD (National Center for Supercomputer Applications' HyperText Transfer Protocol Daemon), and two are Pentiums running Windows NT. The NT machines run (1) a free NT HTTP server from EMWAC (European Microsoft WindowsNT Application Centre--Germany) and (2) the test version of Netscape's NT server. One of the Unix servers is dedicated to the public WWW-based Rohm and Haas pages. We're evaluating distributed servers for use throughout Asia-Pacific--for both internal applications and external access. In particular, an important area of investigation for us is use of our NT-based WWW server for access to ODBC-compliant databases. Secure database access would be a powerful tool for enabling customers to search Rohm and Haas databases over the WWW.

Remote Access for traveling/home-based users: Remote access to systems remains a significant challenge for our company worldwide and in particular in Asia-Pacific. The primary application of remote access services in Asia-Pacific is cc:Mail Mobile and to a growing extent the mobile Lotus Notes client running over 9.6 kbps X.25 lines. For batch communications, X.25 provides acceptable performance. We also provide other remote services that are targeted to specific requirements (and have their own inherent benefits and limitations), including:

Remote Node using ISDN: Enables full LAN participation by a remote PC. While we have not implemented this yet in Asia-Pacific, the growing availability of ISDN suggests that this will be a powerful, high speed capability for telecommuters based in the region. The product enabling remote ISDN access is the Gandalf 5242i Telecommuter Bridge.

Remote Node AccessBuilder: Provides public switched dial-up access enabling full LAN participation. The product enabling this access is 3-COM's AccessBuilder. The benefit of this system is that ubiquitously available dial-up service can be used for providing full LAN service access.

pcAnywhere: Provides direct interactive access limited to remote cc:Mail and Organizer (calendaring) systems. As opposed to the batch file transfer offered by cc:Mail Mobile, the user can access the full set of mail folders stored on the home LAN. This product provides better performance specifically for interactive/remote cc:Mail than does AccessBuilder.

Network Management: Our global data transport network is increasingly managed using SNMP (Simple Network Management Protocol), enabling central monitoring of all network components (including LANs and eventually individual PC's), receipt of alerts when problems are detected, and remote resolution of many local problems. The enterprise network management platform we are using is Hewlett-Packard's OpenView, and we are using Synoptics's intelligent hubs at the LAN level to enable global network management. Full implementation of network management depends on completion of our TCP/IP implementation.

7. FUTURE WAN NETWORKING ISSUES IN ASIA-PACIFIC

The following are the most important issues we face in Asia-Pacific as we move toward global unity of our networking systems:

Network Implementation and Management: We have yet to determine the future configuration of support for network implementation and management. The likelihood is that we'll centrally manage the network from Philadelphia and outsource local implementation, support and trouble-shooting functions. Our I/T staff in the region is limited and our desire is for this staff to focus on services that are value-added to the business, leaving the local "nuts and bolts" issues to a vendor that can cost-effectively handle networking implementations.

Refreshing the hardware/software installed base: It's become apparent that the hardware/software assets will have to be refreshed every 2-3 years given business demands and the rate of change in the technology. The likelihood is that over time we'll move toward arrangements with vendors that support a continual asset refresh, but we have yet to determine specifically how we'll fund and manage this on a global basis.

C. Remote/Traveling user support: Demand for support for the individual user traveling away from his office or working at home is increasing rapidly. Cost-effective and ubiquitous options for the required reliable, high-bandwidth support are still limited. The key to success in the future will be to pace the implementation of digital cellular, ISDN and complementary PC software technologies that satisfy the end-user. Moreover, we have to be mindful not to fragment our internal support resources.

8. RECOMMENDATIONS TO OTHERS

Based on our experience implementing our Asia-Pacific network, we recommend that others undertaking similar implementations

Converge rapidly to standards: In order to minimize difficulties with network interconnections, it's critical to plan in detail the migration to standard protocols and systems. Though there may be significant near-term costs to replace non-standard facilities, it's critical to deploy selected standards as rapidly as possible to ensure a high degree of inter-operability and to reduce the real costs of implementation.

Work closely with strategic suppliers: In order to deploy today's technology as well as to plan for the future, it's important to develop a very sound working relationship with a few selected suppliers of telecommunications services, hardware and software. The rapid pace of change of the technology and the need to creatively plan systems dictate that information technology planners and managers have an intimate knowledge of suppliers' offerings. With this knowledge, one can ensure against wrong decisions as well as influence vendor directions.

Manage expectations: Each system end-user and business manager tends to have his/her own expectations about various facets of the system including functionality, cost, ease-of-use, etc. It's critical to the success of information technology deployment that these expectations be shaped by the managers and analysts most familiar with the systems' deliverables. To truly succeed, a technically sound implementation must also meet the criteria for success as defined by those who use it as well as by those business managers who are funding it.

9. SUMMARY

We're now frequently constrained by cost, service availability, software limitations, limited internal support, and other factors as we move toward unifying R&H's global network. In Asia-Pacific, the drivers for network unity are greatest because of the remoteness of our sites and the requirements to be informed of business and research activities all over the world. Nonetheless, the rapid evolution toward a cost-effective, manageable global network in R&H will favorably transform our global operations and strengthen our business position. The continued success of this network is dependent on our ability to converge to standards, work closely with our strategic suppliers, and manage expectations. The impact as well as challenges will be greatest in our Asia-Pacific operations.

TELECOM ALLIANCES FOR EMERGING ECONOMIES: BREAKING THE CYCLE OF UNDER-DEVELOPMENT THROUGH STRATEGIC LEARNING ALLIANCES

Joan Kelly and Linda Booth

"Nothing can contribute more to a developing countries' economic well-being than a state of the art telecommunications infrastructure, along with privatization and education."

This conclusion, reached by John Naisbitt in his latest book Global Paradox , parallels the views of today's global telecommunications industry. Yet much of the developing world is still without the basics in telecommunications infrastructure. The ITU's 1995 WorldTel feasibility study reports that of the world's five billion people, only one billion have access to simple telecommunications. Less developed countries account for more than 77% of the world's population, but only 5% of the world's phone lines.[1]

Well aware of being left behind, developing nations are trying to implement telecommunications infrastructure development and liberalization of their government owned enterprises. According to the ITU, these countries want to spend $40 billion a year to improve their telecom systems. Severe shortages in funding, and lack of technical and managerial skills are emerging as critical barriers to these nations' visions of joining the global village.

Infrastructure development and privatization is a formidable undertaking for any nation. The post-industrialized world has broadly accepted that free market conditions foster economic well being, despite the loss of power and control by the few to the many. Trillions of dollars continue to be invested in the modernization of vast infrastructures, equipment, facilities, technological advances, and retraining and education of millions of people who run and operate these enterprises. Virtually every major corporation engaged in the shift from monopolistic governance to a free market environment has been limited not by lack of technology or funding, but by the need to re-equip their total workforce with the skills, knowledge, judgment, experience, and commitment required to operate in a competitive and increasingly global business environment. Consider however, the monumental task facing emerging economies, who in their quest to survive as well as prosper, have begun the work of telecom infrastructure reform without benefit of solid funding, basic infrastructures, and an educated or technically skilled workforce. Despite the roadblocks, seventeen developing countries have privatized since 1993, and fourteen more intend to privatize by 1997.

STRATEGIC ALLIANCES - CLOSING THE GAP OF INFRASTRUCTURE DEVELOPMENT

The size of financial requirements and the experience of developing countries attempting to modernize and expand their telecommunications networks, has led the global investment community to conclude "...that the BEST and possibly the only affordable way to help these countries is through private, not public sector funding." The WorldTel feasibility study continues "....we are convinced that the 'old game' of wireline expansion by state-owned monopolies will continue to fail....". Fortunately a 'new game' can finally be created where those countries that are ready to play by commercial rules can quickly become winners..."[2]

With the focus on private investment as the means of bringing less developed countries into the global village, alliances of all kinds are forming as the potentially ideal means of creating win-win outcomes for both the providers and recipients of technology. The mix of competencies is nothing short of ideal; emerging economies have essentially untapped and loyal markets with an unencumbered network; companies have technology ,"know how" and money. Examples of these unions are plentiful. In nearly every privatization that is taking place in emerging economies, some form of alliance has helped the move to liberalization. These partnerships are becoming the cornerstone of the telecom industry as a means of securing improvements for developing nations.

What is emerging from the collective experience of alliances between developed and developing economies is a broadly defined blueprint of success criteria, guidelines for both parties, and a more clearly defined approach for developing economies to follow to become attractive investment candidates. Many developing nations involved in telecom reform are taking a hard look at the attractiveness of their country to potential partners and investors. Clearly these countries have gotten the message that there is a 'new game', and they want to learn the rules of engagement as quickly as possible. What is particularly interesting to the authors, is that emerging and developing nations see partnerships as a means of tackling their broader issues of education and managerial expertise. In its studies of alliances between developed and emerging economies, The Alliance Collaborative has found that developing nations pursuing telecom reform give extremely high priority to a potential partners' willingness and ability to transfer and share skills, knowledge, managerial and operational expertise in their selection criteria for choosing partners for alliances. These nations recognize that money and technology are not enough to sustain their future economic progress, without a more solid foundation of skilled managers, technicians and operators.

For telecom monopolies, a perspective partners' 'willingness to transfer skills, knowledge and training' is second in importance only to 'long term trusting relationships'. As countries become more experienced in the commercial environment, a partners' willingness and effectiveness at transferring skills is not as vital, but still ranks in the top three or four desired attributes of each stage of reform.

THE ROLE OF EFFECTIVE MANAGEMENT IN TELECOM REFORM

In addressing the issues of policy development and implementation of the massive social and economic change inherent in privatizations, ministers and executives of developing nations face their greatest challenge. In the words of Mahmoud El-Soury, Chairman of ARENTO (Egypt), " The management skills required to lead the changes in the process of reforms and implementing policies are vital. It is clear from the experience of the developed countries where such reforms have been introduced and implemented that the retraining and reformation of knowledge and working methods is probably the most difficult challenge in the transformation to the new environment."[3] Emerging economies must leapfrog not only technological advances; they must leap the hurdles of poverty, managerial inexperience, a poorly trained workforce, lack of education in the population, free market inexperience, and for some illiteracy, corruption, and political instability.

Skill shortages not only exist in the developing world. One European telecom executive managing an international joint venture in the Former Soviet Union cited a shortage of experienced managerial and operational talent from any nation as the prime risk factor in his company. Corporations, having cut back extensively in recent years on their expensive expat and world wide training programs, are now faced with shortages of managers skilled in working or living in foreign environments, and managing partnerships among multiple nationalities . As the world goes global, emerging management expertise seems to be moving in the other direction. For the telecom industry, global by nature, this trend could prove disastrous. It is evident that the developed and developing world have a lot to gain by reconsidering their approach to skill development.

It is clearly in the interest of the global telecom community to see that countries succeed in their reformation efforts, and that partnerships with these nations are successful for developed countries as well as the nations themselves. We believe that alliances between these parties offer a prime opportunity to further telecom reform, to provide the much sought after advances in education and skill levels in the developing world, and to create a cadre of highly skilled 'global managers'.

We see alliances as an ideal 'practice field' for learning for all parties involved, adding minimal costs that can easily be recouped by such factors as improved performance, on time project completion, lower project risk, and an improved 'annuity' stream from efficient operations. Further, the benefit to developing nations in terms of enhanced skill and operating expertise will go far beyond the immediate, and provide an invaluable experience base for the country.

THE CREATION OF LEARNING ALLIANCES

The compelling marriage of organizational learning practices, and methods for successful alliance operation, may provide the 'practice field' for learning that will deliver the above mentioned bottom line results for alliances between developed and emerging economies. Opportunities for learning show up in the gaps between our intentions and the results we achieve. According to an Alliance Collaborative survey, "less than one in four 'deals' achieves the intended outcome of either partner."[4]

An example of an ideal 'practice field' in the realm of global telecom alliances, is the common strategy to achieve technology transfer among developed and emerging economies through BOT (Build, Operate, Transfer). This strategy is almost completely dependent on the transfer of learning and operational expertise to achieve its intended results. For BOT to be successful for both parties over the long term, learning must be the primary focus, not technology. It is an openness to supporting the other party's learning, and a willingness to learn together, that gets to the heart of the skill gap between developing and emerging economies. Most corporations and many countries may know how to problem solve, create a sound strategic plan, set up a marketing strategy, build operating and maintenance capabilities, etc. But do they know how to learn or do these things together, or to teach each other what they need to know collectively to make an alliance outcome successful? According to Arie de Geus, head of planning for Royal Dutch Shell, "The ability to learn faster than your competitors may be the only sustainable competitive advantage." The ability to learn fast and learn together with diverse global partners is certainly the great challenge facing industries like telecommunications as they enter the 21st century, and is potentially the golden key for emerging and developing economies in transforming their societies into more prosperous and stable environments.

Through the creation of Learning Alliances, partners can improve both their own performance, as well as the likelihood that the alliance will achieve its intended results. A Learning Alliance can be defined as an organization which continually enhances its capacity to create its own future. The idea of a learning organization took seed over 30 years and gained international recognition with the success of Peter Senge's book, "The Fifth Discipline."[5] Learning organizations represent the only type of working environment that can be competitive in the "knowledge-value" era, described by Taichi Sakaiya, a former MIT economist and author. Learning organizations pay attention to at least five component disciplines, which are constantly practiced but never mastered. The five disciplines are Shared Vision, Personal Mastery, Mental Models, Team Learning, and Systems Thinking. All of these disciplines are of benefit when addressing the complex relationships and differing priorities inherent in alliances between developed and emerging economies. Let us define these five disciplines and consider how they may help alliances among partners in the developed and developing world.

Shared Vision: the ability of an organization and partnership to create a deeply meaningful and broadly held sense of direction and common sense of purpose.

Creating genuinely shared visions will dramatically increase the commitment and focus of a partnership. Many people still believe that creating a vision is a leader's job. However, the real work of this discipline is in the constant re-articulation by the people who work in the alliance, of their collective vision, values, and how the alliance fits into their respective larger worlds.

Personal Mastery: developing capacity and personal commitment to clarify what is most important to the people in the partnership, and building the skills and competence collectively to achieve it.

Mental Models: developing the capacity to reflect on, surface, and test our assumptions and to see how our assumptions shape our actions. Mental models are our deeply held beliefs, assumptions, pictures, and stories about how the world works, and include assumptions and beliefs about our partners.

Team Learning: developing capacity for collective intelligence. Team learning, unlike team building, is not a discipline of enhancing team spirit or improving the skills of team members. Team learning, as described by Art Kleiner (an author of The Fifth Discipline Fieldbook) is about "building a team's capacity to think and act in new synergistic ways, with full coordination and a sense of unity. The skills of reflection, skillful discussion (balancing advocacy and inquiry), and dialogue are the work of those serious about team learning.

Systems Thinking: the ability to see the whole, perceive long term patterns, understand interdependencies and better recognize the consequences of our actions. This discipline is core to success in a global economy.

AN IN-DEPTH LOOK AT MENTAL MODELS

While all five disciplines have applicability to learning for international strategic alliances, none is more problematic than mental models. Perhaps the greatest leverage can be gained by taking a close look at this discipline.

"*Without changing our patterns of thought, we will not be able to solve the problems that we created with our current pattern of thought.*"

Albert Einstein, in his above comment, recognized the dilemma inherent in mental models, and the risks we face in not learning to examine, share, and adjust our assumptions to a changing world.

When asked to speak at Telecom '95 about why the gap remains in between the developed and developing world, Ms. Judith O'Neill humorously responded, "its an attitude problem."[6] Ms. O'Neill, a well known legal advisor who has assisted many telecom reform efforts, was referring to the limited gains made in the developing world despite effort, commitment and desire by counties, funding organizations and private industry alike. Small rather than large gains have been achieved, she concluded, because realities conflict with deep-seated images of what relationships should be, or how relationships should work. This is complicated exponentially by differing cultures, and differing economic viewpoints inherent between the public and private sectors, and the different perspectives between the developed and developing worlds. Such "mental models" severely limit potential, forcing individuals, countries and companies into old patterns of thinking and acting, much to each other's detriment. The opportunity in alliances is to surface, test, explore and improve mental models among partners, providing breakthrough concepts and frameworks that allow for vastly improved outcomes. These discoveries may be an alliance's greatest leverage for success.

Let's look at some examples that shape the way telecommunications companies and developing nations view their positions in seeking partnerships with each other. For companies, the priorities and assumptions most often highlighted are:

"We form alliances only with a stable country who has an international focus. The country must have a trained workforce and partnering mentality."

"Countries must have a national policy and strategic telecom plan, regulatory and legal systems in place, and fair pricing."

Now let's compare these with the commonly held priorities and mental models of developing nations looking to form alliances with corporations;

"We're looking for trustworthy relationships with companies built over the long term, who understand and appreciate our values and culture, and are willing to share revenues in proportional amounts."

While these frameworks hold significant value to the respective parties, one can see their potential for limitation and restriction. In addressing mental models, alliances have the opportunity to surface all parties' frame of references, recognize their limitations, and begin to create shared mental models that simultaneously address the needs of the individual partners, and the collective. In reality we do not *have* these mental models, we *are* our models. As Peter Senge explains, "they are a medium through which we and the world interact. They are inextricable woven into our personal life history and sense of who we are." Changing mental models is immensely challenging, and can best be done by collective learning. In order to create Learning Alliances, we must be willing to examine and change the way WE OURSELVES think.

Nynex demonstrated its willingness to meet this challenge. While in the midst of negotiations with Thailand a coup broke out. Despite the conventional wisdom of avoiding political strife, Nynex and their potential partner, CP of Thailand, jointly assessed the situation and decided to weather the storm. Today Nynex's $470 million investment is worth $1.2 billion.[7] In retrospect, they commented that "sometimes conventional wisdom is just plain wrong."

THE LADDER OF INFERENCE

Becoming a Learning Alliance requires a change from the traditional mode of avoiding mistakes to a learner's "beginner's mind". It is a difficult transition, particularly for global executives, government ministers, or telecom engineers and operators. They may believe that they are ready to put the "learning' behind, and begin the "doing". It is counter-intuitive to think that you must relearn with your partners, when money and time are ticking away. In the case of UTEL, the alliance between the Ukraine, AT&T, Deutch Telecom and France Telecom, this was exactly the thinking at the outset of their agreement. Several years later, with project and budget goals far behind, they engaged in a exercise that allowed them to surface the enormous differences in operational style that contributed heavily to the problems they were experiencing. In the words on one project manager, it was that exercise that got the project, and the alliance, back on track.

One tool that can help is the *Ladder of Inference*, a framework for exploring mental models, developed by Chris Argyris of MIT. The Ladder of Inference depicts the process we use to draw conclusive opinions and judgments from observable data, showing that individual evaluations are, in reality, often highly abstract and inferential. This tool can help alliance partners monitor their own "leaps of inference" as they take observable data (for example: XYZ telecom CEO walks into 9:00 meeting at 9:20) and go up the ladder to cultural meaning ("he's late") to the level of values and assumptions ("he's not committed to this alliance, we had better be careful") to taking action ("we should reconsider the viability of this alliance"). All of this most often happens unconsciously. The ladder of inference can provide an alliance team with a framework to see where they are 'on the ladder' and for 'walking back down the ladder' to understand what is really happening in the relationship, and to begin to manage by facts, not just by opinions and inference.

STEPS TOWARD CREATING A LEARNING ALLIANCE

The process for creating a Learning Alliance can begin with the following four steps, for alliances between developed and emerging economies, they are critical to insure successful technological and skill transfer:

1. Gain a common understanding of organizational learning concepts.

Research shows that successful alliance partners spend time at the front end of their partnerships 'launching' the new relationship together and sorting through the specifics. We recommend using this launch time to learn the concepts of the five disciplines involved in organizational learning, and to begin the experience of working on "live" issues in the partnership to negotiate and collaborate on the overall vision, mutual goals, operational approach, researching, and measurements required by the alliance.

2. Create an environment conducive to learning;

If we think about it, learning usually involves making mistakes because we are trying something we may never have done before. This if particularly true in many global partnerships; they involve risk. Yet to learn, we must approach the work from a "beginner's mind", one that is open to other viewpoints. How can an organizationally and culturally diverse group of people begin to create an environment conducive to learning? A guiding principle of successful learning is to create a safe learning environment in which participants can explore their own behaviors, and adapt and change as the partnership requires to meet the parties mutual goals. Some factors to consider in creating an environment conducive to learning include assessing group size and attendance at meetings; including people who feel invested in joint outcomes, clear communications and meeting agendas; honoring and integrating the various cultural backgrounds of the partners; and allowing for a 'check-in' time at the beginning of each meeting to assess and acknowledge any changes that occur in partners home organizations and personal lives that will impact the alliance.

3. Develop the capacity to surface and work with Mental Models;

In addition to creating an appropriate space for learning, the alliance partners need to build their capacity to collectively surface, share and test their mental models. The tool that is specifically helpful in providing a framework is "The Ladder of Inference" reviewed in the previous section.

4. Learn to look for systematic interconnections and consequences of actions;

A partnerships ability to see the big picture can be the difference between achieving the joint goals of the alliance and disaster. If both partners cannot see the big picture, if they do not understand the connections, they are likely to do the wrong thing. They may do something that seems to reward the alliance in the short term, but erode it over the long term, or one partner may act only on their own behalf, which destroys trust and thus viability of the partnership. Systems thinking tools can provide a powerful means for mapping out a group's perception of a problem or issue. "Systems archetypes', according to MIT's Daniel Kim, "embody a storyline or theory about a system behavior that illuminates the structures that are driving the behaviors." Learning to use these archetypes can facilitate a partnerships' ability to stay focused on its mutually beneficial goals and outcomes. An example of this is outlined in the illustration below. An example of this is in the use of the Build -Operate-Transfer strategy referred to earlier. Let's look at this strategy through the lens of the "Shifting the Burden" archetype. A problem symptom, (the unsuccessful transfer of skills during the transfer stage) is often resolved with a quick fix (giving long term operational license to experts from outside the host country), which alleviates the symptom in the short term, but results in the side effect of an erosion of a developing nation's ability to equip itself with basic technological and managerial expertise. Because the quick fix solution is obvious and immediate, they divert attention away from the real or fundamental source of the problem (a widening gap in infrastructure development), and the search for a long term solution to enhancing in-country expertise.

MEETING THE CHALLENGE

The creation of Learning Alliances requires focus, willingness to work differently, and a commitment to the long term growth and prosperity of both the specific alliance and the developing countries involved. Engaging in Learning Alliances is a choice to be made by partners, but for the developed world it is one means of achieving the greater goal of closing the gap in telecom infrastructure development around the world.

NOTES

[1] WorldTel Feasibility Study for the ITU, McKinsey Consulting, 1995.

[2] Ibid

[3] Mahmond El-Soury, Chairman of the Board of ARENTO, in his Telecom 95 address, "Managing for Change, Regulating for Growth", Geneva, October 1995.

[4] Kelly, Joan and Parsons, Ron,:"Managing The Complexity of Telecom Partnerships", Pacific Telecommunications Review, December, 1994.

[5] Senge, Peter, *The Fifth Discipline,* Harvard University Press

[6] Dr. Judith O'Neill, in her Telecom 95 address, Resourcing for Growth-Capital Formation, Human Resources, Geneva, October, 1995.

[7] "The Last Frontier", Business Week, September 18, 1995, pg 102.

MAKING INFORMATION TECHNOLOGY ADVANCES WORK FOR YOU: BPR AND COMMUNICATION

Rein P Mere
Director
KPMG Management Consulting
Canberra, Australia

ABSTRACT

Breakthroughs in IT and communications technologies have made possible a wide range of service applications which are now deceptively within reach of most businesses and organisations. However, the costs and penalties for making the wrong choices have escalated dramatically.

This paper draws together some of the most common pitfalls confronting businesses and Governments, and explores how they could be avoided. It looks at why various problems arise and discusses how organisations could extract maximum benefit from investing in these technological advances.

1. THE ENVIRONMENT

Recent advances in IT and communications technologies and applications have been breathtaking. No sooner have we got our minds around broadband services and been dazzled by the promise of multimedia and the information super highway. Terms such as "Surfing the Internet", "cyberspace" and the "World Wide Web" have suddenly appeared.

The number of expert panels and conferences dealing with these developments seem to be escalating at the same rate! Never has so much confusion been created for so many, by so few!

The developments are real. Breakthroughs in IT and communications technologies have made possible a wide range of service applications which are now deceptively within reach of most businesses and organisations. Most value added services rely on IT applications and are software driven. However, the costs and penalties for making the wrong choices have escalated dramatically.

But what are the driving forces behind this lemming-like rush for the latest IT-driven communications services and software applications? Is it really just a fascination with the best and brightest?

1.1 THE DRIVING FORCES

The pressures arise from an increasingly competitive marketplace, more educated and increasingly demanding users, and the globalisation of world economies. For business, it is a fundamental question of survival to have a better product, be more efficient and carve greater market share. In the search for more efficient organisational processes, these latest developments seem to offer an attractive opportunity.

For development planners in the emerging economies of the Asia Pacific region, there are incredible pressures to meet competing national development, economic and cultural objectives from scarce and limited national resources. Telecommunications now touches almost every sector of the economy and is increasingly integrated with social activity. Providing for these new technological developments is unfamiliar territory, but the promise of major benefits is difficult to resist.

Governments of developed and developing countries alike are under pressure to produce more effective and efficient regulations. Each wants to ensure that business opportunities for local firms will be enhanced, appropriate foreign investment in the development of telecommunications infrastructure and services will be encouraged, and that broader national development and public interest objectives can also be met.

Getting the balance right requires courage! Often there is tension between the Government's goals for national development, and the divergent objectives of business and consumers.

A pragmatic and informed appraisal of the operating environment is required to identify the real problems and to provide an objective assessment of the opportunities presented by various technologies to avoid being pushed into technology-led solutions.

New technology and IT applications in particular, are increasingly the key catalyst to dramatically improving business processes. Often processes cannot be redesigned without it. But there is a danger that technological solutions will be designed separately from business requirements, creating major problems downstream for the organisation.

To demonstrate the range of other critical issues that must be considered, this paper draws on the latest advances in business and organisational analysis and relates the investment in IT and communications solutions to application of Business Process Re-engineering (BPR).

2. BUSINESS PROCESS RE-ENGINEERING

Although BPR is now an increasingly popular phrase in the business lexicon, there is significant confusion as to what it encompasses.

To many people, business process re-design is synonymous with BPR. However, this examines how **existing** processes can be modified to obtain improvements in performance. With BPR, **new processes** are designed to enable the objectives of the organisation to be met.

BPR involves the radical re-engineering of an organisation and its operations to achieve dramatic improvements in performance in the areas of cost, quality, and cycle time and other business parameters critical to the organisation. Existing assumptions governing the organisation are challenged, paving the way for the radical redesign of how "the business" of the enterprise is conducted.

The outcome is a fundamental reshaping of business processes, organisational structure, information technology and physical infrastructures, together with a re-orientation of corporate values and culture.

2.1 THE BUSINESS REQUIREMENT

Many organisations today are not positioned to successfully execute their strategies. Changes in business processes and organisational structure tend to lag changes in markets, technology and economic reforms, and take considerable time to be reflected in revised business strategies and directions. The result is that work processes and functional alignments are devoted to the challenges and business requirements of the past.

The traditional approach of short term "fixes" leads to increasingly complex work processes and a strategic mismatch reflected in structure, accountabilities, systems and frameworks.

The penalties of ineffective work processes are substantial and not always obvious. Resource allocation is inappropriate, customer service and quality of decision making suffer. There is an internal focus on resources, excessive compartmentalisation and layering, and duplication of effort. Human resources are not managed effectively and motivation and commitment are low.

In these circumstances the potential impact of new technologies is not well exploited. There is an over-focus on improved IT tools, rather than on the improved *application* of tools.

Tinkering with the machinery will not cure the ills which have become entrenched over time. BPR provides the circuit breaker necessary to bring about dramatic improvements and force the pace of change.

2.2 THE BPR FRAMEWORK

The KPMG framework for BPR is comprehensive but flexible to enable the real needs of the organisation to be met. The methodology comprises nine key components carried out in sequence, which are integrated to produce a clear and comprehensive business solution for the future.

1. **Business Direction**
2. **Scoping and Targeting**
3. **Process Design**
4. **Organisation and People**
5. **Technology**
6. **Physical Infrastructure**
7. **Policies, Regulations and Legislation**
8. **Implementation Planning & Financing**
9. **Implementation**

So how can BPR help make choices about tantalising technological applications or various regulatory alternatives?

Only when the real business direction of the organisation and its strategies have been confirmed, and its processes and organisational structures analysed does it become meaningful to address technology. The BPR approach recognises that business processes should be re-designed *before* being automated, not the other way around.

While technological expertise is an essential input, the technology design must come after and be driven by the outcomes of business process re-design. If this sequence it is not respected, the organisation risks making huge capital investments in expensive technology to support what may later prove to be dysfunctional processes.

It must be emphasised that re-designing business processes is only *one component* of BPR. An organisation may have the best processes in place, but without properly trained and empowered employees and the right choices of supporting technologies, the newly established goals will still be out of reach.

This paper will focus on two of the BPR components: *Business Direction* and *Policies, Regulations and Legislation* , where KPMG has found the most common pitfalls to lie. Related components will also be briefly addressed.

By dealing with the *principles* of BPR rather than detail, the issues should remain relevant to government regulators, providers of telecommunications equipment and services, and to business users.

3. CLARIFYING THE BUSINESS DIRECTION

The primary purpose of the first component of BPR is to confirm, with precision, who are the organisation's clients, their requirements and expectations, and what services, products and outcomes the organisation currently delivers and will deliver in the future. Strategies and cultural values guiding the delivery of services and products are articulated, and any "partners" in the delivery of these services and their roles will also be identified.

The critical success factors that are paramount to the organisation meeting its clients' requirements and expectations and achieving its key objectives are formulated. The organisation will then set the business targets that will define the objectives of the re-engineering exercise.

A first appraisal might suggest that this would be a relatively simple, targeted and logical process merely confirming what the organisation is already doing. KPMG's experience has been, however, that this phase is rarely simple, and has often proved to be controversial because it challenges established beliefs.

It has emerged as **the high risk area** for most organisations.

Where the strategic business direction is not clear or flawed, the resources of the organisation are being poorly utilised. The organisation will consistently under-perform.

In these circumstances, investment in advanced technological systems and applications may improve the existing processes, but do little to enhance the competitive position and profitability of the organisation. It could even magnify the poverty of the current business direction.

The parallel holds true for adopting particular regulatory strategies.

3.1 THE PUNISHING PACE OF CHANGE

The problems seem to stem from the rapid pace of change - in markets, technology, organisational alignments and strategic alliances, and regulatory developments, as well as in client needs, wants and expectations. Organisations are increasingly working at the limits of their sphere of experience and competence, and being required to make decisions in uncharted waters - and quickly!

Organisations often fail to recognise the changes that have occurred in their operating environment and to adjust their business directions and strategies accordingly. Not only has there been local change, but often their business has moved into new and strange environments which do not respond well to their existing processes and corporate style.

To mix a metaphor, they are "acting regionally, but thinking locally!"

The key factor seems to be the speed of response that is demanded from organisations today. For businesses, this is demonstrated by the shortened processing cycle times in markets and how critical these have become.

For governments, it is reflected in the rate of regulatory change that has been required to keep up with technological and economic developments and the changing national social fabric.

For many organisations, business or government, the changes are associated with a shift from the familiar domestic environment to having to deal with unfamiliar regional or global challenges.

Despite the popular preoccupation with deregulation and privatisation, governments have never been more involved in the affairs of business than they are today. In most cases, the changes have resulted in *re-regulation* rather than *less* regulation. Yet it is surprising how many organisations fail to factor accurately the role of governments into their business plans and strategies.

Underlying each of these considerations is the failure to address adequately differences in culture, and the critical differences in the needs, wants and priorities of clients, strategic partners, customers and governments.

3.2 NEEDS, WANTS AND PRIORITIES

A curious belief seems to be permeating telecommunications fora, particularly among developed countries, that the needs, wants and priorities of the countries in the Asia Pacific region are somehow the same. This belief is also reflected in the approach taken by some regulators.

It is important to recognise that the needs and objectives of developed, developing and emerging economies are different and reflect their different stage of development. Further, the interests of individual countries often differ markedly from the interests of companies. Their objectives diverge.

There is no orthodoxy - technological, economic or regulatory - which will meet all of these needs.

3.3 SOME PERSPECTIVES

For businesses, the rapidly changing commercial, regulatory and technological environment creates huge demands for access to accurate and timely information on markets, products, customers, suppliers and how their company is operating. They also need appropriate and effective business processes to enhance their competitive position. Their priority is for cost-effective new services, increased efficiency and lower costs.

The situation in developing countries is vastly different. They, too, have experienced accelerated growth and very high market demand for telephone services but their domestic operators can no longer cope. They are looking increasingly to international partners to assist in the development of their telecommunications infrastructure and services.

In Thailand, for example, the telephone penetration is about 4 per 100 inhabitants and there is a waiting list of 1.6 million applications. The Telephone Organisation of Thailand (TOT) has the objective of installing an additional six million lines by the end of the 7th National Development Plan. The initiative is highly capital intensive - Thailand imported some US$1.75 billion of telecommunications equipment in 1994.

Thailand is also embarking on a program of liberalisation, with the eventual privatisation of TOT, to help achieve these goals.

Similarly, the Philippines Long Distance Telephone Company has indicated that under existing major expansion plans it will not be able to meet the huge backlog of 789,000 applications for telephone lines by 1996. These plans were drawn up in 1985 on the basis of growth forecasts of 6%, but the annual growth has turned out to be closer to 10%.

A revised Six Year Program released by the National Economic Development Authority plans to overcome the backlog in three to five years and proposes privatisation of all existing state-owned telecommunications facilities.

Despite the best efforts of the International Telecommunication Union (ITU) and the Maitland Commission, more than 90% of the world's telephones are in fewer than 10 countries. In emerging economies, the stark dilemma for governments and telecommunications authorities is how to create millions of telephone lines to support national development.

For example, in Indonesia, a country of 190 million people, the current telephone penetration is about 0.8 telephones per 100. That is planned to increase to 5 per 100 by the year 2000, which will require the installation of 7 million additional lines over the next six years, at a cost of some US$10 billion.

The overwhelming concern is infrastructure establishment and how to fund it. Enhanced communications services on the information superhighway are not yet a pressing priority.

3.4 GOVERNMENTS

The priorities of governments differ. In developed countries, governments concentrate more on the "big picture" - microeconomic reform, market behaviour, competition policy, export facilitation, and particular sectoral policies for employment or regional development reasons.

In developing countries, however, investment in telecommunications represents a significant part of the national budget and involves the outlay of scarce foreign exchange. The governments will be seeking to satisfy simultaneously a whole range of national and cultural development objectives. Such complex, inter-related requirements are unfamiliar to most developed country suppliers and prospective business partners.

Without a clear understanding of clients' priorities, needs and wants, initiatives are likely to fail. Such oversights are all too common in government and private sector organisations practising traditional functionally-driven planning.

The BPR approach demands a more lateral "across the boundaries" business perspective, which emphasises the importance of "up front" analysis to clarify, define and understand the operating environment.

No amount of investment in advanced IT systems and applications will overcome this myopia. Neither will regulatory frameworks which fail to accommodate the differences endure.

4. POLICIES, REGULATIONS AND LEGISLATION

While *Policies, Regulations and Legislation* is the seventh component in the BPR sequence, it has emerged as the **second most important** set of considerations. It impacts fundamentally on the nature and timing of investment in advanced technology systems and applications, or choice of regulatory direction.

Few organisations seem to recognise that the role of policies and regulatory infrastructure in the region has as much to do with culture as it does with economic and national development. The issue of culture, or rather the lack of sensitivity to culture, has emerged as a key factor in why regional initiatives fail.

This is not simply a "north-south" issue. The interests of developing countries in the region can differ widely, reflecting their different stages of development as well as cultural heritage and regional identity. One reason why development in the region is uneven, is because they have very different national policy objectives, priorities and concerns.

It tends to be overlooked that new markets are also opening up *within* developed countries, each with its own micro-culture. In a highly competitive mesh of markets, no company can afford to ignore the culture of particular groups of customers. Indeed, some organisations seem to be blind to the fact that they have a culture themselves, and a particular style in the way they conduct their business.

The issue of corporate culture is also a major problem for both the regulator and the operator. This is particularly so in countries which are converting their telecommunications regime from a long-standing monopoly to a national operator with a competitive outlook in a liberalised market.

4.1 THE LEGISLATIVE FRAMEWORK

The legislative environment is complex. There are different layers of regulatory requirements across national, regional, and international jurisdictions.

Few countries in the Asia Pacific region have comprehensive, up to date legislation covering each sector, or a tradition of formal codes governing corporate operations. Consequently, much is open to interpretation and depends on cultural attitude to legislation and unwritten codes of conduct.

Each country reflects its legal traditions and embodies the distinctiveness of its community cultures and behavioural norms. It is impossible to separate national economic development policies from the legislative and regulatory frameworks, which are themselves based on cultural and societal values.

The English legal tradition places great emphasis on statutory codification and formal mechanisms for ensuring compliance. Regional traditions, however, often operate on the basis of customary norms entrenched in shared community values and consensus. Compliance mechanisms and penalties are rarely laid down in legislation and only invoked by governments when required, through general reserve powers.

Cultural differences have many dimensions. For example, among the South Pacific island countries, there is the "South Pacific Way". There is a different sense of time, and western style deadlines and high pressure business attitudes are not appropriate or valued. There is respect for status, position and age, and patience is a necessity! The business environment places high value on personal relationships and trust, built up over time. It is a very different ball-game.

4.2 REGULATORY IMPERIALISM

Despite the critical role that cultural values and societal norms play in shaping the policies and regulatory frameworks of the countries of the Asia Pacific region, it is surprising to see how widespread the gospel of deregulation and privatisation has become. Advocates uncritically promote the new

366

orthodoxy, and those heeding it seem not to realise the contradictions they are being asked to accept.

Studies of regional telecommunications development usually attempt to summarise, *inter alia*, the status of regulatory development on a country by country basis. As most of the research is sponsored by organisations such as the OECD and the ITU, researchers tend to use crude measures based on northern hemisphere developed country models.

Typically, these studies set out the degree of market liberalisation in a country - whether it is a monopoly, partially deregulated, or a competitive telecommunications environment. The implicit imperative is that there exists a standard, perfect market structure that is somehow a measure of "regulatory correctness".

Research presents the result as an indicator of the extent of the "undeveloped" state of most of the regulatory regimes in the Asia Pacific region. However, it only indicates the very different experience of OECD countries in the development of their telecommunications sectors. These countries have mature telecommunications markets, established networks and infrastructure, and a wide and disparate range of users.

Confronted with the rich tapestry of cultures and attitudes and varied state of telecommunications infrastructure in the Asia Pacific region, OECD countries see this as *ad hoc* development. They consider their northern hemisphere models to be the picture of orderly market development, and there are strong pressures on the countries in the region to follow this orthodoxy.

It does not seem to be understood that competition and privatisation are not logical solutions for solving infrastructure establishment problems.

4.3 ASIA PACIFIC ORTHODOXY

The developing countries in the Asia Pacific region are resisting the blind rush to salvation. For example, Thailand and the Philippines are flirting with privatisation but maintaining control of their national objectives. The countries are also experimenting with their own version of regulatory frameworks and to formulate development and investment guidelines which meet their particular needs.

Those who wish to do business with these countries need to understand *why* the northern hemisphere gospel is largely (but politely) being ignored, and why a new Asia Pacific orthodoxy is emerging. They also need to recognise that telecommunications and broadcasting are given particular regulatory attention because they go to the heart of national culture and social identity.

With patience and understanding, there are many opportunities for all parties to share in the growth in the region. There is also room for a high degree of innovation. Setting business directions involves a wide range of considerations, which rarely mirror the familiar world in which most developed country organisations have become used to operating.

5. SCOPING AND TARGETING

The purpose of this BPR component is to define existing processes and select focus areas for future process design. It will also identify key potential opportunities for transforming the organisation. The outcomes will focus the analysis exclusively on those areas of the organisation which have the greatest impact on its ability to achieve the business and performance objectives identified in *Business Direction* .

This component also investigates possible business "enablers" including technology, and will guide the nature and extent of process and infrastructure redesign.

Because of differences in their business directions and operating environments, the *Scoping and Targeting* component may lead to quite different results for organisations that have very similar business processes.

As opportunities for redesign are investigated and bottlenecks and inefficiencies identified, recommendations are made on how the organisation can implement immediate changes that will result in demonstrable benefits now. "Quick Hits" are important to build support and generate momentum.

The *Scoping and Targeting* component also focuses the work of the later phases.

6. PROCESS DESIGN

The objective of this component is to design the new work processes identified and directed by the *Scoping and Targeting* component. The design of work processes is conducted in a series of creative, thought provoking and challenging work sessions. All existing assumptions and ways of doing business are challenged.

367

A process design team designs a new process through work simplification or work-step elimination, the application of new computer technologies, or other appropriate re-design "enablers".

The principal outputs of the *Process Design* component are the re-designed work processes, including workflow diagrams, the information required, changed or produced by each work step, identification of the external stakeholders involved in the process, and performance estimates for each work-step and process.

This stage will also analyse the overall implications of the new processes for the organisation and its existing supporting infrastructure.

7. ORGANISATION AND PEOPLE

It is important to describe the organisational culture that is envisaged for the *transformed* organisation. The key elements will guide the design of the organisational model, and will also have an impact on how the project team applies basic organisational design principles (eg spans of control, levels of supervision, centralisation versus decentralisation).

Examples of key elements of the organisation's culture that should be defined include:

- **Management style:** includes identifying the degree of control versus delegation required.
- **Internal communications:** the degree to which information flows directly to where it is needed, or needs to be shared laterally and between levels.
- **Client focus:** may have implications for the need to be located close to clients, as well as the optimum level of centralisation versus decentralisation of services.
- **Human resources management practices:** the manner in which the organisation will address workforce adjustments in light of the new business solution.
- **Rewards and recognition:** determining the role that rewards and recognition will play to support the attainment of performance objectives.
- **Training and development:** extent of the organisation's commitment to providing training to its employees and encouraging multi-skilling; and
- **Innovation and risk-taking:** the degree of innovation and risk-taking required and supported in the new environment.

Designing an optimal organisational structure requires consideration of various options for grouping the new work processes and their underlying activities. Application of appropriate organisational principles and operational considerations will guide the design of the structure.

Outcomes and considerations arising in the course of this component are likely to impact on the processes that have already been designed in the previous component. These processes need to be re-visited and the appropriate adjustments made. BPR is not a "one pass" process, and its strength is enhanced by appropriate iteration and testing.

In particular, the outcomes of this phase will have important linkages with the *Technology* component and the *Physical Infrastructure* component. Consequently, the KPMG approach is to undertake the *Organisation and People* component in parallel with the *Technology* and *Physical Infrastructure* components.

All of these considerations and outcomes will have a significant impact on the nature, extent and scope of investments that should be made in advanced IT systems and applications. Any investment which did not take these into account, including arrangements for training staff, would be premature, costly and potentially ineffective.

8. TECHNOLOGY

The main focus of the *Technology* component is to identify the technology that is required to achieve and maintain the business solution, assess the impacts on the existing technology infrastructure, clarify risks and costs, and begin to formulate plans for implementation of the technology.

Some pilot projects may be initiated to test technology opportunities. The level of detail required in investigations and analysis will vary depending upon the organisation.

The KPMG definition of "technology" is broad in scope and includes information technology and telecommunications services and applications, as well as other technologies such as robotics, computers, manufacturing and repair equipment etc.

The *Technology* component builds upon the work initiated in the *Scoping and Targeting* and *Process*

Design components. For example, it is likely that some enabling technologies were identified as potential opportunities for improvement, and some of the "Quick Hits" identified in the early components may have involved the application of certain types of technologies. The *Process Design* component would also have considered the application of various technologies in designing the new work processes for the organisation.

Because of the iterative nature of the *Process Design*, *Technology* and other components, new technology options and opportunities may be identified through this work phase. These new opportunities would necessitate once again re-examining the work processes. In turn, this could create impacts in other components.

9. CONTROL OF THE ENTERPRISE

Success in the marketplace depends on the ability to exercise efficient and effective control over the organisation's resources. This is a complex task in today's demanding environment. Whether the organisation is a commercial supplier or user, or a government regulatory and planning authority, the way in which it exercises control over its business processes can be represented in the functional system diagram at **Figure 1**.

The identified functions, operations, checks and controls are straightforward. However, the diagram invites you to characterise each of the blocks to reflect the functions and operations of *your* enterprise, and to place it in the context of *your* stakeholders and operating environment.

It should quickly become obvious that we are not dealing with a linear system, or an environment which obeys simple rules or even the same timeframes.

Where one or more of the "feedback loops" is not operating effectively or is missing altogether, organisations begin to "drift". For example, there may be a change in the operating environment or in the expectations of stakeholders. If the organisation does not have mechanisms in place which will analyse the situation, determine an appropriate response, change the organisational focus, adjust the management controls and modify the standards against which the system response is monitored, the outputs will be increasingly inappropriate.

In such a complex system, technology has a critical role to play. However, unless the organisational "building blocks" have first been correctly defined and integrated through carefully applied business renewal processes such as BPR, technology cannot solve the problems.

Organisations, whether private sector or government, which seek to embrace a new-found orthodoxy in the hope that it will solve all their problems, are badly advised.

Organisations must take control of their business affairs and apply their own considerable knowledge to determining how they want their "businesses" to operate. Misdirected technology, however powerful, will not achieve success.

To make sound investments in technology, the organisation must first understand the environment in which it is operating, and the central role that cultural traditions play in business practices, priorities and regulatory frameworks.

The BPR process applies a structured, dynamic framework which ensures that all of these critical factors are identified and taken into account.

10. INVESTING FOR SUCCESS

This paper has demonstrated that there is more to making successful investments in information technology advances than just choosing the right technology.

In fact, the choices are not so much about *technology* as they are about clearly defining business requirements and processes.

Technology is, of course, important. Often it is the only way in which some objectives can be achieved, and it is a key enabler in improving business processes.

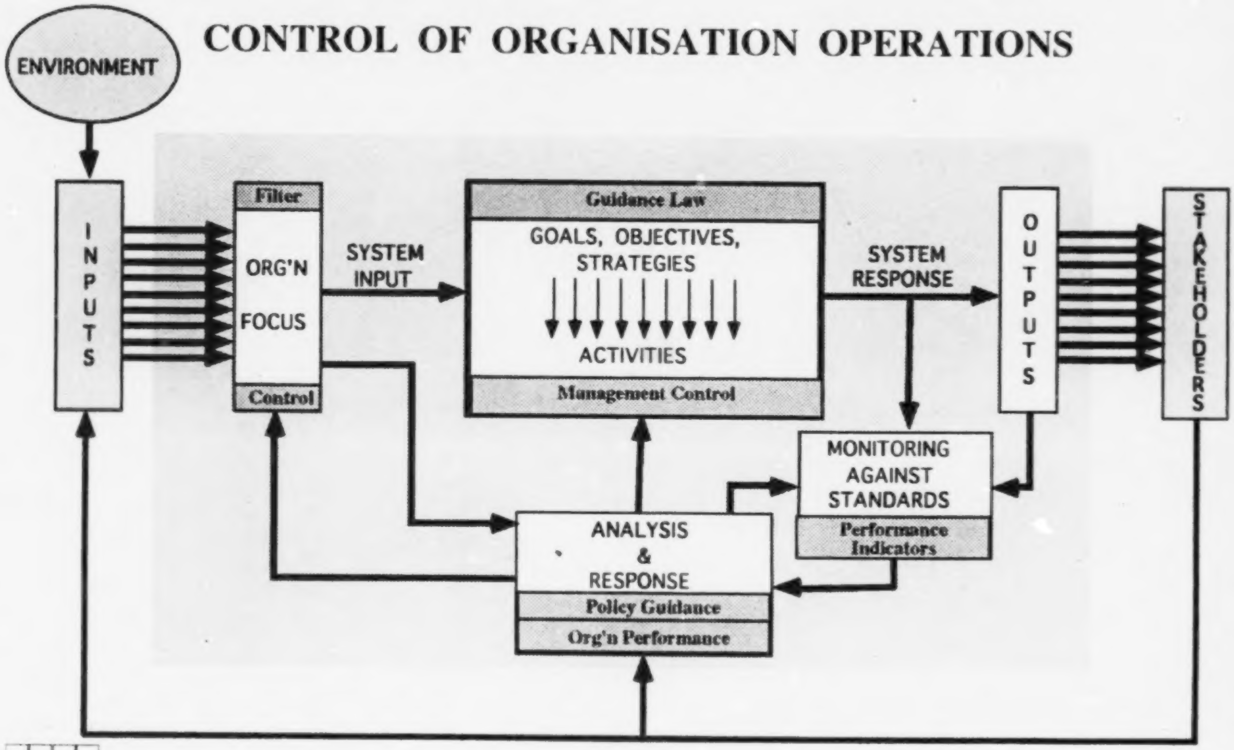
Wise investment in advanced business technologies can significantly increase the productivity and effectiveness of the organisation and give it a market edge.

But technology investment must be placed in the broader business perspective.

Where business planning and evaluation recognise the complexities and cultural dimensions of the operating environment, and are conducted in the context of continuing organisational renewal, the technology initiative is much more likely to succeed.

Most importantly, such a comprehensive approach is essential for establishing a sound foundation for future growth.

CONTROL OF ORGANISATION OPERATIONS


ENVIRONMENT
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Management Control
SYSTEM
RESPONSE
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STAKEHOLDERS
MONITORING
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Performance
Indicators
ANALYSIS
&
RESPONSE
Policy Guidance
Org'n Performance

KPMG Management Consulting

Figure 1

Satellite Solutions for the Oil & Gas Industry

Rajiv Kumaraswamy

Omnes

Houston, TX, USA

1. Abstract

The exploration and production sector of the oil and gas industry are increasing their activities in the Asia-Pacific region. With the increased activities, comes the need for effective communication solutions. Satellite solutions (VSAT and INMARSAT) offer the oil and gas customer the best alternative to meet their communication requirements during the various phases of exploration and production.

2. Introduction

The exploration and production sector of the oil and gas industry primarily operate in remote areas. Despite the remoteness of the locations, the oil and gas industry demands the ability to use the same value-added communication capabilities at the remote sites that they can access at the head office. In the remote areas, terrestrial options are either not available or cannot adequately meet the oil and gas customer's requirements. In such cases, a satellite solution is the only or the optimum option available to offer a "seamless" network to the oil and gas customer.

This paper will discuss the following:

1. The oil and gas market in the Asia-Pacific;
2. The communication requirements during the various stages of the oil production process and how satellite technology can be used effectively during each stage

3. The Asia-Pacific Market

The International Energy Agency (IEA) projected a worldwide demand for petroleum products of 69.3 million barrels per day by Year End 1995[1]. By comparison, in 1994 the worldwide demand was 67.75 million barrels per day.

In 1995, the Asia-Pacific crude oil and gas production accounted for approximately 10% of the worldwide production[2]. The large oil producing countries in Asia include China (which is in the top five oil producing countries in the world), Indonesia, India, Malaysia and Australia (see table 1).

In addition, countries like Vietnam are forecasted to have significant reserves. A steady string of oil discoveries in 1994 and carried into the first half of 1995, has boosted the confidence of the oil companies to sustain the growing drilling surge. In the first five months of 1995, Vietnam averaged approximately 173,000 barrels per day of oil, while in comparison in 1994 Vietnam averaged 134,000 b/d per day (28% growth) - giving Vietnam one of the highest growth rates in oil production in the world.

Similarly, India has seen a 22% growth in its oil production in the first five months of 1995, in comparison to the first five months of 1994. As a region, the Asia-Pacific market had the second

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[1] Oil & Gas Journal, July 31, 1995 (pg. 46)

[2] Oil & Gas Journal, August 14, 1995 (pg. 62)

TABLE 1

Asia-Pacific Oil Production (January-May Average Production)

Country	**1995** (in 1,000 b/d)	**1994** (in 1,000 b/d)	**Percentage Change**
China	2,946	2,956	-0.3%
Indonesia	1,329	1,306	1.8%
India	690	563	22.6%
Malaysia	680	646	5.3%
Australia	530	523	1.3%
Vietnam	173	135	28.1%
Asia-Pacific	**6,785**	**6,605**	**2.7%**
Total World	**61,064**	**60,322**	**1.2%**

Source: Oil & Gas Journal, 14 August 1995 highest growth in oil production between 1994 and 1995 (second to Western Europe)[3]. This indicates the future potential that the region has in the energy sector.

As discussed, the countries in Asia which are the large oil producing nations also happen to be some of the largest countries (in terms of area). Most of the oil deposits found to date are in the less inhabited areas, where a reliable communication infrastructure is not available. The oil industry has realized the benefits of reliable, cost-effective telecommunications services. Beyond the increases in productivity and potential for reduction in operating cost, reliable communications are essential for safety and environmental purposes.

4. The Communication Requirements

As oil exploration and production activities continue to grow in the Asia-Pacific, communication requirements continue to grow. There are three stages in the oil production lifecycle during which communication requirements generally change.

a) Exploration stage

b) Development and early production stage

c) Mature production stage

During the exploration stage, rapid connectivity and mobility are the driving factors. Typically, during this stage the customer is trying to identify areas where large oil and/or gas reserves are located. For offshore exploration, the customer may use drilling rigs or seismic vessels to identify potential sites. As the customer may have to move fairly frequently during this stage (as they search for areas with large oil and/or gas deposits), mobility is the key aspect of this stage. The type of communication services needed during the "exploration" phase includes intermittent voice and data, as well as high speed data file transfer (to transfer the seismic data from the remote site for analysis).

Typically, an evaluation-type seismic file (which are sent about once a day) vary in size from 10 - 100 megabytes - thus the reason for the high speed data capability. The high speed data link is required to transmit seismic data back to the central processing centers for evaluation. The reason for the central processing centers to evaluate the seismic data is to make most efficient use of the resources - by placing the petrophysicists in centralized locations they could study multiple locations. If they were at the exploration site, they could only evaluate that one site. For the central processing network to work, a reliable, effective communication link is a must.

The INMARSAT A and B terminals are generally the best options during this stage for the provision of communication. Presently, a large number of the energy industry customers use INMARSAT-A terminals during the exploration stage. An INMARSAT A terminal (the oldest of the INMARSAT terminals) is capable of providing two-way telephone, telex, fax, electronic mail and other forms of data communication (including high speed data). Recent developments in data compression techniques enable the transmission of high-definition still photographs, and even slow-scan video, to and from an INMARSAT-A ship earth station.

The INMARSAT-B terminals which use digital technology are considered the successor to INMARSAT-A, providing services at generally lower charges but with the antenna size and weight nearly the same as that of the INMARSAT-A. The INMARSAT-B is capable of providing services at up to 64 kbit/s. The INMARSAT-M which was introduced in 1992, and is small and lighter than the INMARSAT-A terminals.

The INMARSAT service offerings is a viable solution with lower usage. When

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[3] Ibid.

373

usage begins to increase then the INMARSAT option becomes less attractive, because it is based on a per-minute basis. At this stage the energy industry customer will begin to look at VSAT options.

As the project moves to the development and production stage, the customer generally has requirements for data, voice and facsimile connectivity from the rig-site to their local offices as well as their headquarters. Additionally, in most instances there are multiple subcontractors at the rig-site, and the customer wants to ensure that his subcontractors communication requirements are met as well.

In addition to voice and fax services, the type of data services typically required are e-mail, and PC type file transfers. File transfers are particularly important to communicate well logs, well test data and drilling reports between the rig site and the company office (either locally or internationally). The amount of time that the remote locations utilize the communication network, increase significantly at this stage in comparison to the exploration stage.

Therefore, using a usage-based communication network like INMARSAT is not the best solution, as costs tend to escalate very rapidly in an usage-based system like INMARSAT. Using VSAT technology where costs are fixed irrespective of usage is a better alternative at the production stage.

The VSAT network configuration will vary based on the customer requirements. The two primary types of VSAT network configurations currently used are:

SCPC Multipoint-to-Multipoint Network: This type of network is best for a customer with requirements for meshed connectivity between rig sites, camps and multiple local offices. In such a network, a centralized network control system will handle the call set-up requests (voice and data), connect and disconnect, as well as control/manage the remote sites. With the availability of demand assigned multiple access (DAMA) technology, the Single Channel Per Carrier (SCPC) network can be more efficiently used as the remote sites can share the bandwidth, and use it only when needed.

TDM/TDMA Network: This type of network is suited for customers who primarily require data communication. The TDM/TDMA network is designed for communication between the remote terminal and a host, and not for communication between two remote terminals (which is double-hop).

TDM/TDMA traffic is bursty in nature with some batch transmission during certain hours of the day (typically off-peak hours). The energy sector prefers to use this technology if most of their applications are low throughput traffic such as e-mail, LAN data and interactive applications. Voice communications can also be supported, however, if too much voice communication exist the capacity will be tied up by voice channels, thus affecting the time delays and availability of data circuits.

The third stage is the mature production stage where the customer has requirements for a wide array of communication services, and the requirements can be measured in multiples of 64 kbit/s. The ability to meet the longer term requirements of administrative, scientific and logistical centers is essential at this stage. The customer needs to have access to local, regional and international telecommunication services.

Infrastructure class networks based on single channel per carrier modulation and access techniques (such as INTELSAT Business Services) using larger earth stations offer a viable solution at this stage. The key distinguishing feature is that the capacity resources at this stage are dedicated for the specific network and are not shared.

Omnes Satellite Solutions

Omnes is a new company, that was established in January 1995. However, Omnes has made significant progress in developing its satellite services product. Both of the Omnes parent companies - Schlumberger, Ltd. and Cable & Wireless, Plc. have extensive experience in the satellite industry, which has attributed to the significant progress in the Omnes satellite service product.

Since 1985, Schlumberger (a large oilfield services company) has been using VSAT technology to transmit logging information from the wellsite to the company offices. The Schlumberger network known as LOGNET, has the distinction of being the first Ku-band VSAT network in the world. Today, LOGNET is a network of over 120 VSATs in the U.S. and is managed by Omnes.

Omnes addresses the needs of oil and gas customers in North America, Africa, Latin America and Asia. Most of the satellite solutions that Omnes currently provides are VSAT, though INMARSAT and infrastructure-class solutions are also offered.

For the INMARSAT market, Omnes expects to finalize a contract with an INMARSAT carrier by December 1995 to provide INMARSAT A, B, M services at a competitive price for oil and gas customers. The Omnes INMARSAT offering will be globally available.

Omnes can offer VSAT solutions in North America, Latin America, Africa and parts of Asia, for customers in the development and early production stage. In the Asia region Omnes does not offer a single solution, instead, we work with the customer to design a network solution that best meets their needs.

For customers in the mature production stage, Omnes evaluates the options available on a case-by-case basis and proposes a customized solution to the customer. Since most of the oil production in the Asian region is still in the early stage, Omnes has yet to see a high demand for infrastructure class service in the region (in comparison to Latin America and Africa). However, this is likely to change in the future as oil production increases in countries like India, Vietnam and the Sakhalin Islands.

Conclusion

The oil industry is increasing its presence in the Asia-Pacific region as it becomes more important as an oil producing region. The benefits of reliable, cost-effective telecommunications services relate directly to substantial increases in productivity realized within all aspects of energy projects. Satellite services is the premier communication technology that connects the remote site to the rest of the world, and therefore the building block for the rest of the network. As a result, satellite services will continue to grow as a key component of communication solutions in the energy sector in the Asia-Pacific.

Mobile Satellite Services:
Pie in the Sky or a Practical Solution
to the Telecom Needs of the Pacific?

Donald B. Falle
Teleglobe World Mobility
Montreal, Canada

1. ABSTRACT

Mobile satellite services (MSS) are at the leading edge of the rapid technological changes that will form the backdrop for discussions at PTC '96. This paper will provide an overview of the principal MSS projects on the drawing boards and, more importantly, will examine how relevant these proposals are in terms of their ability to satisfy the real market needs of telecommunications carriers and end users in the Pacific region. Among the issues to be examined: Where are the main target markets for MSS. What information-technology applications are best-suited to space-based solutions? How cost-effective are such services likely to be?

2. BACKGROUND

The influential business magazine *Barron's* wasn't far off the mark when it described the heated competition among proponents of the various mobile satellite service (MSS) projects as "a space race that will rival the Sputnik-Explorer contests of the 1950s."

It was less than a year ago, on January 31, 1995, that the US Federal Communications Commission (FCC) issued licences for the construction, testing and US operations of three satellite-based systems—Globalstar, Iridium and Odyssey—which intend to offer mobile voice and data services on a worldwide basis. With that decision, the race was officially on.

Spectrum for these three systems—1.6 GHz up-link and 2.5 GHz down-link—was allocated at a World Administrative Radio Conference (WARC) in 1992. And in November 1995, WARC allocated them feeder-link frequencies in the C and Ka bands.

Current projections call for the first of those three original entrants to begin service by late 1999. A fourth would-be entrant in this field, ICO (originally known as INMARSAT-P), has begun construction—although it has yet to receive a go-ahead from the FCC to provide service in the United States.

Still another mobile satellite system, ORBCOMM, will provide data-only services on a global basis, again using spectrum allocated in 1992. And, although most of the media attention has been focussed on those four, high-profile projects mentioned above, it is the "work-horse" ORBCOMM service that will in fact be first to market.

ORBCOMM received FCC approval in October 1994 and made history a couple of months ago as the first MSS LEO system in the world to be pronounced ready for service. The two initial ORBCOMM satellites were successfully launched in early 1995 and final agreements were signed last autumn for the financing and construction of an expanded 36-satellite constellation. Commercial service is scheduled to begin February 7, 1996, following the completion of an extensive testing program.

Not surprisingly, backers of all the MSS projects appear convinced of the merits of their respective systems, in terms of both the inherent technology and the services they'll be able to provide.

This paper will evaluate the proposed services from the perspective of potential users and customers. Among the questions we'll attempt to answer: Is there, indeed, a market need for MSS?

If so, who are the main potential users? And which MSS systems and/or applications are likely to be most attractive to customers in terms of their cost-benefit ratio?

The focus will be on the overall marketability of MSS, rather than the relative merits of the various systems. Nevertheless, a disclaimer is perhaps in order here, given that the author is an employee of Teleglobe, which has an interest in two of the MSS projects mentioned above—Odyssey and ORBCOMM.

However, I would ask you to also bear in mind the fact that Teleglobe—alone among the major backers of these projects—is not directly involved in the business of building satellites or related space hardware. We don't stand to benefit simply by putting some hardware up in space. Thus, we were able to assess the various MSS systems—and the potential market for them—with a considerable degree of objectivity, before entering the fray.

As an established player in the intercontinental telecommunications business, Teleglobe had the opportunity to participate in virtually every one of the MSS projects. Needless to say, our inside knowledge of the global communications market gave us somewhat of edge in assessing their relative merits. As long-time members of both INMARSAT and INTELSAT, we know something of the satellite business. And we have a history in mobile as well. Perhaps most importantly, Teleglobe has a solid understanding of what makes a technology sell—and of how to reach potential end users.

The point is that, when it came to sizing up the competing MSS proposals, we examined them with the detached eye of the potential investor who is motivated more by the prospect of solid, bottom-line returns generated by success in the marketplace than by the marvels of space science. It is from that down-to-earth, consumer-oriented perspective on MSS that the views expressed here have been developed—a perspective, I might add, that would serve many PTC delegates well as they evaluate the business potential of the various satellite services.

3. THE SYSTEMS

Following is a brief overview of the five proposed MSS projects (Figure 1). However, it should be noted that—due to their financial and technical complexity—it is far from certain that all these proposals ultimately will get off the ground.

Figure 1

MOBILE SATELLITE SYSTEM PLAYERS

• GLOBALSTAR	48-satellite LEO system
• ICO	66-satellite MEO system
• IRIDIUM	12-satellite LEO system
• ODYSSEY	10-satellite MEO system
• ORBCOMM	36-satellite LEO system

Globalstar - from Loral and Qualcomm, comprises a constellation of 48 satellites deployed in eight orbital planes, each with six equally spaced satellites, in low-earth orbit (LEO) at 1,414 kilometres (km). Although its architecture is similar in some respects to Iridium, Globalstar would be interconnected with existing, earth-based telecom infrastructure through 100 to 200 earth stations. The large number of earth stations is made necessary by virtue of the fact that Globalstar satellites would not communicate with one another in space. Gateways would connect mobile users to the public switched network, which would complete the calls to fixed users. Globalstar's subscriber links will utilize a modulation method known as code-division multiple access or "CDMA".

ICO - from INMARSAT (the International Maritime Satellite Organization), comprises a constellation of 10 satellites deployed in two orbital planes in a medium-earth orbit (MEO) at 10,300 km. It would use an access system known as time-division, multiple access or "TDMA" and requires about eight earth stations that would be interconnected with the public network. ICO has selected a mobile service frequency at 2 GHz which, although recently allocated for such use by the WARC, is heavily congested with terrestrial microwave uses in almost every country in the world.

Iridium - from Motorola was the pioneer MSS project and is widely regarded as the most ambitious in terms of size and complexity. It comprises 66 satellites orbiting in six planes, supported by a cellular-type network architecture. The system's satellite cross-link capability permits point-to-point direct subscriber access from anywhere in the world in a seamless environment. Iridium could conceivably operate independently of the public switched telephone network, and will use TDMA for subscriber-link modulation.

Odyssey - from Teleglobe and TRW Inc., shares the same basic hub-and-spoke architecture as Globalstar but comprises a smaller constellation of 12 satellites orbiting in three planes at a higher, medium-earth orbit of 10,354 km. The inherent benefits of a higher orbit include reduced satellite start-up requirements and implementation time, reduced obstruction interference, increased service availability and longer satellite life-expectancy. *(Incidentally, the U.S. Patent and Trademark Office issued TRW a patent for several key aspects of the Odyssey system in July of 1995.)*

Odyssey will offer global voice, fax and paging services through hand-held terminals with seamless links to existing wire-line and wireless networks. It uses TDMA modulation and will require eight earth stations.

All of the above-mentioned systems plan to offer voice communication via small, portable devices with omni-directional antennas, which implies that little user cooperation will be required to establish contact. The systems will all require users to be either near a window or outdoors to send and receive calls via satellite service, although several (ICO, Iridium and Odyssey) will have a higher-power paging mode.

However, that's where the similarities end. Unlike terrestrial cellular systems, which all use similar technology, these space-based systems will be very different in terms of both the technologies deployed and the precise services resulting from the choices of technology.

ORBCOMM - a joint-venture of Teleglobe and U.S.-based Orbital Sciences Corp., is pretty much in a category of its own in terms of the projects which already have received a green light from the FCC. As indicated above,ORBCOMM eventually will comprise a constellation of up to 36 small satellites deployed in three planes at a low-earth orbit of 785 km and a series of gateway earth stations. Intended primarily for industrial applications, it is capable of providing low-cost, two-way data, paging and position-determination services to subscribers worldwide via hand-held communicators or personal computers.

In the context of PTC, it should be noted that an Asian investor—Malaysian-based TRI, which owns Celcom, one of the fastest-growing cellular operators in Asia—has also become a partner in ORBCOMM by acquiring a portion of Teleglobe's equity in the venture.

4. ASSESSMENT

4.1 POTENTIAL MARKETS

Our assessments indicate that there is room for competition and multiple service providers in the MSS market. But the best way to realistically evaluate the potential of global mobile is to forget—at least for the moment—about the undoubtedly marvellous technological capabilities of satellites, and focus instead on services. Who is going to use MSS, and for what purposes?

At Teleglobe, it's our belief that astute backers of MSS projects should be promoting and marketing access networks—just as many cellular operators are doing these days in order to significantly expand usage beyond their core business subscribers.

We anticipate an inevitable, rapid convergence of earth- and space-based communication modes that will be market-driven. Consider that North America, Western Europe and Japan—which collectively represent only about 15% of global population—account for some 90% of existing telephones. More than half the world's population have never made a phone call. And most of them live more than two hours from the nearest telephone.

These vast, under-served regions—many of them fast-developing areas situated around the perimeter of the Pacific in Asia and Latin America—are potentially lucrative markets for MSS. For instance, if we look across to the developing countries of Asia alone, we find an immense population of 3 billion people served by only 75 million telephone lines. To put that number in perspective, consider that Canada has about 16 million phone lines to serve a relatively minuscule population of 30 million.

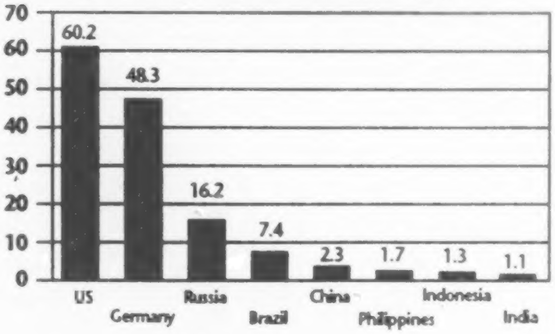
That translates into almost 60 main telephone lines for every 100 Americans, compared with only 2.3 lines per 100 people in China, 1.7 in the Philippines, 1.3 in

Indonesia and 1.1 in India (Figure 2). Despite massive infrastructure investments aimed at closing this gap, the global waiting list for basic telephone service has been steadily increasing for more than a decade.

Figure 2

1994 TELEPHONE PENETRATION RATES

MAIN TELEPHONE LINES PER 100 INHABITANTS



Furthermore, in North America, Japan and other regions of the Pacific rim which already have easy access to cell phones, pagers, portable fax machines and such like, users seem to be constantly in search of more and better services. The cellular penetration rate in the United States jumped by 50% from 1993 to 1994, to just under 10%. Yet Americans' appetite for telecom services is far from sated and there are a number of areas of the United States not adequately served by conventional cellular networks—areas where MSS could provide ubiquity.

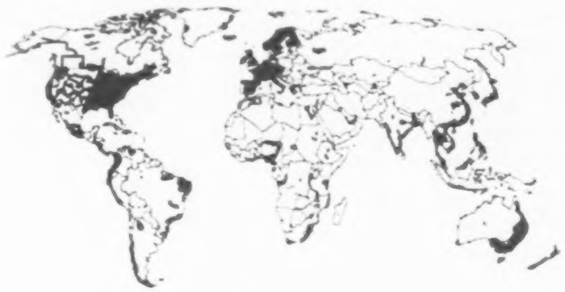
So we expect to see unprecedented growth in wireless communications, with Personal Communications Satellite Services (PCSS) capturing a significant portion of this growth.

Forecasts call for the wireless market to grow to 120 million subscribers by the year 2000, from today's 50 million-plus. And based on past experience, these numbers are probably conservative. Delegates may recall that, when cellular phones first hit the market back in 1982, forecasters figured it would take until the year 2000 to ring up the first 1 million sales.

However, even with the very-rapid growth that is anticipated by the end of this decade, only 15 to 20% of the world's land mass will be covered by conventional cellular service (Figure 3). And while an estimated 90% of Americans will, by then, have access to wireless services, 50% of the land mass of the United States will remain uncovered.

Figure 3

TERRITORIES COVERED BY CELLULAR NETWORK IN THE YEAR 2000



The most promising targets for MSS will be: 1) emerging markets, where they can provide a permanent telecommunications network, or be utilized as an interim network while infrastructure is developed, and; 2) developed countries, where they will complement existing cellular service and new PCS coverage.

In the first instance—emerging markets—Asia, Africa and Latin America offer the greatest opportunity and will for some time to come. Low price will be a major consideration in these regions. Other factors that favour the use of MSS technology here include: relatively low power requirements, rapid deployment and ease of installation, and system reliability in regions where technical back-up is either scarce or non-existent.

North America, followed by Europe, represent the most market potential for MSS as a complementary service.

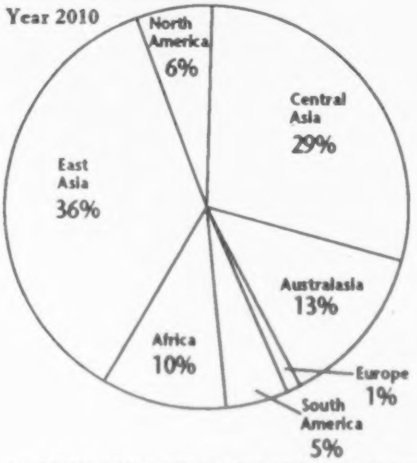
Other potentially significant user groups include international business travellers—the so-called global roamers—the military, police, customs and other government agencies. But in assessing the market potential of MSS, we tend to discount the significance of the international business-traveller segment. In our view, most international travellers will, in fact, opt for more-economical methods of keeping in touch.

Overall, however, we see a very significant market for MSS. The Odyssey program alone is forecasting that it will attract nearly 7 million subscribers by the year 2008.

By the year 2010, we see a worldwide addressable market for fixed-wireless MSS of more than 17 million subscribers (Figure 4). Some 36% of those subscribers are expected to reside in East Asia, 29% in Central Asia and 13% in Australasia. So the Pacific rim really is the primary target market in this sector.

Figure 4

FIXED-WIRELESS SEGMENT ADDRESSABLE MARKETS

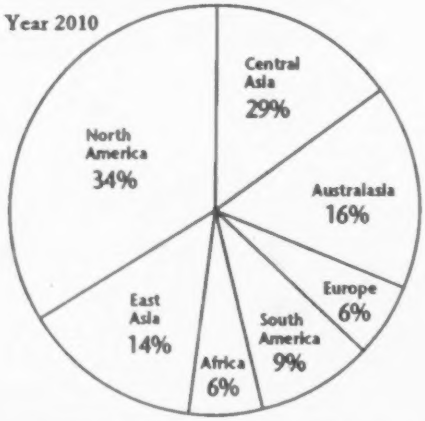


Worldwide Addressable Market=17.46M Subscribers

As for cellular extension, forecasts indicate a worldwide addressable market of some 8 million subscribers by that same 2010 date (Figure 5), with North America accounting for 34%, Central and East Asia combined another 43% and Australasia 16%.

Figure 5

CELLULAR EXTENSION SEGMENT ADDRESSABLE MARKETS



Worldwide Addressable Market=8.11M Subscribers

4.2 APPLICATIONS

I've already alluded to the fact that, in our view, MSS today is about where cellular was 10 years or so ago. Some people are sceptical about the potential demand for MSS—as was the case with cellular. And they're uncertain about how many real, cost-effective applications exist out there in the marketplace.

However, indications we get from the market confirm our view that the list of practical applications for MSS—including both mobile-to-mobile and mobile-to-fixed-user scenarios—is long and growing.

Some MSS applications are obvious—for instance, extending and complementing conventional cellular service in regions of low population density where it is not economically feasible to offer terrestrial wireless. In this context, satellites can be seen as cellular base stations floating in space, providing a cost-effective means of seamlessly extending service to virtually every corner of the globe.

Other applications are not so obvious—at least not to those of us living and working in the urban areas of developed countries that are well served by advanced telecommunications. With the advent of MSS, voice, data and facsimile services, as well as value-added products like voice-mail and E-mail, will be accessible to people on the go and those living and working in even the remotest regions of the world. You'll be able to pick up a telephone in Singapore or San Francisco and reach a colleague or customer in the hinterlands of China or the rain forests of the Amazon.

With our Odyssey system, for instance, the mayor of a small village in a remote region of China could utilize a fixed-antenna MSS hook-up to communicate with the outside world. And there is little doubt that reliable, affordable MSS will become standard equipment on remote oil rigs and at mining and construction projects undertaken in isolated areas.

For other users, MSS will serve as the communications equivalent of a spare tire. The capability of calling anywhere at any time will be theirs for a small additional subscription—subject to relatively higher user fees that will apply in the instances where they actually use the service.

The number and variety of potential applications for MSS data services alone is more extensive than anyone likely imagined when ORBCOMM was first on the drawing board.

Here again, there are a number of obvious applications, including messaging of various sorts and position-determination services, which will enable users to keep track of trucks, box cars, and automobiles—virtually anything that moves, anywhere on the planet. It is noteworthy in this regard that Qualcomm's Omnitracs unit, a leader in the provision of communication and location services to the trucking industry worldwide, has signed on as an ORBCOMM reseller. Qualcomm is also an investor in Globalstar.

At any rate, you can add to that core list of MSS data applications just about any asset you might wish to monitor—pipelines, alarm systems, even vending machines to avoid needless trips for servicing and refilling. Another rather-intriguing application entails the tracking of wildlife, both to monitor and protect endangered species and to carry out the sorts of environmental-impact studies that have become obligatory in most developed countries for anyone wishing to exploit natural resources.

This might, at first glance, seem a rather frivolous notion. In fact, the tracking of wildlife is very extensive these days—and represents a potentially lucrative niche for operators of MSS position-determination services. In Canada, for example, authorities track some 2,000 moose a year at enormous cost—up to $8,500 (Cdn.) each for the technologically dated devices they hang around the animals' necks. Considering that an ORBCOMM radio transceiver will cost only a fraction of that amount, it's evident the job can be done for a lot less utilizing MSS.

There's also concern these days over disappearing fish stocks. And MSS could also be used to track certain species of fish—by implanting small transceivers in, say, salmon and then installing monitoring stations along the banks of a river.

Should that strike you as too arcane an application, let's return to the more obvious example of rail-car monitoring. If you're already keeping track of the movements of the cars with a satellite-based locator system, it would be a simple step to also monitor the temperatures of refrigerated or heated cars in order to prevent damage to perishable freight. Or how about mounting sensors on the wheels of the rail cars to detect overheated bearings that can cause derailments?

With MSS—voice or data—it's not always the message that's important, but the ability to send a message. For instance, the hunter, fisherman or cross-country skier out enjoying the forest or wilderness area probably doesn't want to actually send a message—unless he becomes lost or his leg is broken! A lot of lives can be saved through the use of satellite-supported emergency locator services—not to mention the time, energy and money expended on needless search-and-rescue operations.

There are a myriad of other personal and consumer-safety MSS applications, a number of which are geared to the automobile. For example, the system could be set up so that a 911 emergency call is automatically placed when a vehicle's air bag deploys, giving the position of the unit and despatching an emergency vehicle. A similar application, in which both major auto makers and automobile clubs have expressed considerable interest, is a break-down/towing button which motorists could use to summon a tow-truck or other assistance in the event of mechanical difficulties.There already is considerable interest from Detroit in this sort of thing.

MSS could also be utilized to keep tabs on people fighting forest fires, on bush pilots and on boaters. You could track icebergs by seeding them with transceivers dropped from aircraft or helicopters. And governments could monitor distant logging operations via MSS to prevent over-cutting. The list of potential applications is virtually endless.

5. CONCLUSION

Without getting too deeply into the relative merits of the respective systems, there is little question that MSS can be successfully marketed around certain core-user segments and myriad niche markets. However, the emphasis must be on providing reliable, low-overhead, user-transparent services, driven by consumer preferences.

Market demand is characterized by the expectation of wire-line voice quality and security and of true mobility. So MSS systems, if they are to satisfy user needs, must be flexible—capable of providing voice, data, facsimile and other value-added services.

Furthermore, they must be priced competitively. A survey of potential MSS users in the United States and Europe[1] indicates that demand for satellite-based PCS falls off sharply at prices over US $1 per minute. And there's no doubt that prices—including the cost of handsets—will play an especially crucial role in determining the success of MSS in markets such as China and India.

Bearing this in mind, Odyssey is talking to various suppliers with the aim of being able to offer dual-mode handsets starting in the $500 US price range. And that figure is expected to be reduced as the number of MSS subscribers grows—as has been the case with conventional cellular, where only a decade or so ago a relatively primitive "car phone" cost around $3,000.

Projected costs of the various MSS projects range from a low of about $2.5 billion to well over double that figure for those projects utilizing constellations of LEO satellites which have a relatively short life span and must be replaced every five to seven years. Of course, these overall system costs largely dictate the level of circuit and subscriber fees that backers of the projects will have to charge if they are to recoup their investments. So lower-cost, lower-risk systems evidently will enjoy a competitive edge in the market place—provided they can deliver on services.

Odyssey is aiming to bring its voice services to market at prices a little under that crucial $1-a-minute figure, which will make them only slightly more expensive than conventional cellular service. Projected rates for other MSS systems range from there up to a high of about $3 a minute.

To give you an idea of how data-only services will be priced, it is anticipated that ORBCOMM units will sell in the $500-to-$800-range, depending on the features required. Monthly access fees for common data services will fall in the $18-to-$25-range, with emergency or "may-day" services available for less than $100 a year.

As with any commercial venture, timing is a big factor. In this regard, Teleglobe understandably takes comfort from the fact that both ORBCOMM and Odyssey are on track to come to market ahead of rival projects.

Of course being first is no guarantee of long-term success. You also have to demonstrate that you can deliver on services that will have compelling appeal to the target user groups—and that can be marketed profitably by your distributers. It's a given that adequate returns are a prerequisite for effective distribution.

In some markets, regional services utilizing geosynchronous (GEO) technology represent potential competition for global MSS systems. But the time delay inherent in the use of GEO satellites is an impediment to consumer acceptance that will place such regional operators at a competitive disadvantage. Given a choice, the majority of end users could be expected to opt for the service with a lesser time delay—unless the alternative is radically cheaper.

A system such as Odyssey represents a very easy "on-ramp" to the information highway for users in the Pacific region, providing both global-mobile capabilities and cost-efficient access to remote areas for fixed wireless applications—the latter a solution which makes a great deal of sense for developing countries.

To sum up then, it is evident that the industry's excitement over the potential of mobile satellite services is not just "pie in the sky". There is a real and very sizeable market for MSS services on all sides of the Pacific—provided they are the right services at the right price. Indeed, as I've already indicated, our market intelligence shows that demand will be sufficiently strong to support several competing MSS projects.

Consequently, we can expect to see multiple winners emerge from this latest "space race"—including the backers of the most successful MSS ventures, as well as millions of end users throughout the Pacific and around the world who'll benefit from a standard of communication impossible to provide with conventional telephony.

ENDNOTE

[1] Source: 1992 marketing survey conducted by the MSP Group of Boston, Mass.

Status of PCS in the United States

John Swart
Telecommunications Research Associates
St. Marys,USA

ABSTRACT

One Personal Communications Service operator began service in the United States in 1995, and several carriers will continue the rollout in 1996. But unlike the PCS or Personal Handiphone Service rollouts in some other countries, the US service will not be a uniform, low-cost alternative to automotive cellular service. PCS markets will feature many different varieties of service, offered with many incompatible radio technologies, with many competitors each taking a different market strategy. This paper reports on the status of PCS licensing, standards, and carrier strategies.

INTRODUCTION

The Federal Communications Commission (FCC) administers spectrum for commercial use in the United States. Since 1990, they have been investigating the proper regulatory environment for Personal Communications Service licensing. Unlike licensing agencies in most other countries, the FCC has decided to define only a minimum set of rules for PCS operators, creating a fair competitive marketplace, and let the competitors independently decide the technology choices, serving areas, and other service aspects. As a result, the offerings of several large PCS providers are likely to feature very different combinations of price, handset design, voice quality, coverage, roaming, and mobility.

Predicting the future is always difficult in a market-driven environment, but the high-level view of the future US PCS marketplace may feature:

Two carriers offering nationwide, automotive cellular service using a combination of 800 MHz cellular licenses and 2 GHz PCS licenses, and dual-band handsets.

One carrier offering nationwide, automotive cellular service using single-band handsets at 2 GHz.

Manufacturers selling unlicensed PCS equipment for private voice and data communications inside buildings, with handsets and data transmitters that may interoperate with the licensed public offerings of the above carriers.

Many carriers offering regional automotive services using a variety of technologies.

A few carriers pursuing the wireless local loop market, encouraging subscribers to disconnect from the wired local service providers and use wireless service for all communications.

Smaller carriers offering local services to niche markets. Some of these niche markets may even be the low-powered, pedestrian service using the standard radio technologies that define PCS in Japan and other countries.

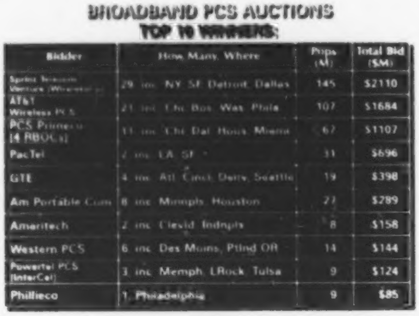
What is clear is that PCS is likely to have a different mix of competitors and service strategies in each metropolitan area, and the competing operators will have incompatible radio technologies deployed.

US PCS LICENSING

The FCC is auctioning 2,070 licenses for PCS, in several separate auctions. 1,968 of these licenses (four licenses in each of 492 geographic territories) cover regions named Basic Trading Areas (BTAs), which correspond roughly to metropolitan areas or collections of rural counties. These BTA licenses permit use of either 10 or 30 MHz of spectrum in the 2 GHz range. 102 other licenses (two licenses in each of 51 geographic territories) cover larger regions named Major Trading Areas, each of which is a collection of several Basic Trading Areas. The MTA licenses are for 30 MHz of spectrum, also in the 2 GHz range, and have already been auctioned. The top ten

383

winners of these MTA licenses are listed in figure 1.



BROADBAND PCS AUCTIONS
TOP 10 WINNERS:

Bidder	How Many, Where	Pops (M)	Total Bid ($M)
Sprint Telecom Venture (Wireless Co)	29 inc NY SF Detroit Dallas	145	$2110
AT&T Wireless PCS	21 inc Chi Bos Was Phila	107	$1684
PCS Primeco [4 RBOCs]	11 inc Chi Dal Hous Miami	67	$1107
PacTel	2 inc LA SF	31	$696
GTE	4 inc Atl Cinci Denv, Seattle	19	$398
Am Portable Com	8 inc Mmphs Houston	27	$289
Ameritech	2 inc Clevld Indnpls	8	$158
Western PCS	6 inc Des Moins, Ptlnd OR	14	$144
Powertel PCS (InterCel)	3 inc Memph LRock Tulsa	9	$124
Phillieco	1, Philadelphia	9	$85

10560

Fig 1

As of the publication date of this paper, an auction for some of the BTA licenses was scheduled to begin December 11, 1995. This round of auctions is open only to companies the FCC has defined as "entrepreneurs": smaller companies and small rural telephone service providers.

In addition to the licensed spectrum, the FCC has set aside three 10-MHz blocks of "Unlicensed PCS spectrum," for customer-owned products which may be located anywhere without FCC coordination. Two of the 10-MHz blocks are for data products, and one is for voice products. These products must obey "spectrum etiquette" rules defined to allow non-interfering sharing of the spectrum.

When the auctions are finished, it is possible that there will be nine or more competing wireless service operators in every metropolitan area: four BTA and two MTA license-holders, in addition to the two cellular providers and one or two Enhanced Special Mobile Radio provider now operating. (There will be fewer operators if the PCS license-holders choose to aggregate smaller licenses into a license of greater bandwidth.)

TECHNOLOGY STANDARDS

Just in case the 2,070 overlapping licenses did not create enough confusion and fragmentation, there are seven radio interface standards that are being issued by the American National Standards Institute (ANSI). Operators of PCS services may choose to base their offering on any of these technologies, or any other radio interface. Again, this is the result of the FCC's interest in letting marketplace dynamics choose the winning technology, rather than an imposed government solution.

Why did ANSI choose to issue seven standards instead of a smaller number? Since there are so many operators with stakes in the decision, each following a different market strategy, there was no way to reach consensus on the single "best" technology. The natural result will be incompatible PCS handsets from the multiple operators.

Table 2 lists the major distinguishing characteristics of the seven ANSI standards, and major PCS operators who have chosen to use each standard. The first three standards will support automotive-speed mobility, but with less-than-landline speech quality. The next two standards, based on cordless technology, offer landline speech quality but do not currently support vehicular mobility. The last two standards are new technology proposals that may support both vehicular mobility and landline quality speech.

ANSI Standards for US PCS Radio Technologies

Automotive-Cellular-Based Standards (Operators)

- CDMA, based on IS-95 US cellular standard (Sprint, PCS Primeco)
- TDMA, based on IS-136 US cellular standard (AT&T)
- TDMA PCS1900, based on GSM cellular standard (Pacific Telesis, American Portable Comm)

Cordless-Based Standards

- PACS, based on Bellcore specifications and the Japanese Personal Handiphone system
- DCT-U, based on European DECT standard

New Technologies (Operators)

- PCS-2000 (Omnipoint)
- Wideband CDMA

ANSI = American National Standards Institute
CDMA = Code Division Multiple Access
TDMA = Time Division Multiple Access
GSM = Global System for Mobile Communications
PACS = Personal Access to Communications Systems
DCT-U = Digital Cordless Telephone in the US
DECT = Digital European Cordless Telecommunications

384

LIKELY STRATEGIES OF LICENSE WINNERS

Each operator is keeping portions of their competitive plans quiet, and all are retaining flexibility to refine strategy, but some plans of the license winners are now becoming more clear through their auction strategies, technology choices, and press announcements.

AT&T Wireless will use its existing cellular licenses in combination with its new PCS properties to build a continental-US-wide automotive wireless network. Handsets will be dual-band, and triple-mode: They will operate in some areas using the US analog cellular (800 MHz) standard, in other areas using the US digital TDMA cellular (800 MHz) standard, and in still other areas using the TDMA PCS (2 GHz) standard. But from the users' perspective, the operating mode will be transparent. This will be a handset and service that works on the AT&T network anywhere in the continental United States. That will distinguish the service from existing cellular operations, which serve only portions of the country and must use roaming partnerships with other carriers to achieve nationwide coverage.

PCS Primeco, a consortium of four cellular operators, has a likely strategy very similar to AT&T's. They hold cellular licenses that cover a large part of the continental US, and have acquired PCS licenses in many other MTAs in an attempt to achieve greater coverage. They may combine cellular and PCS licenses into a nationally-branded automotive wireless service using dual-band handsets, but using CDMA technology.

Sprint Telecommunications Venture is a partnership of Sprint, a long-distance carrier, and three large Cable Television operators: Telecommunications, Inc. (TCI), Comcast, and Cox Cable. They have acquired PCS licenses covering much of the US, and Sprint has spun off its cellular properties so it may acquire or partner with license holders in the remaining areas. Sprint may be able to build a national wireless network under its brand name using a single-band, single-mode phone. (And since cellular-licensed territories and PCS-licensed territories do not share exactly the same boundaries, it may be easier to cover the country with one type of license rather than two types, as in the AT&T and PCS Primeco strategies.) The cable partners in the venture, plus other affiliated cable operators, may host microcell sites on their cable networks to ease the problems of providing coverage throughout an area, and to provide microcells for low-powered, long-battery-life handsets.

Most other winners of the large MTA licenses, and the major players in the "entrepreneurs" auction, have embraced the radio technologies that allow for vehicular mobility. A major reason for this decision is the availability of technology: Cellular-based equipment is ready for deployment now, and time-to-market is critical when there are many competitors. Therefore, their services may be difficult to distinguish from automotive-cellular service providers. But they will operate in smaller territories than the national consortia, so they may carve out local niches for marketable distinction from the national carriers, selling to users who need mobile communications, but without national roaming.

In contrast to the vehicular-mobility providers, the manufacturers of unlicensed PCS equipment will embrace the lower-powered, low-mobility standards, and provide PCS at a lower cost for in-building use. It is likely that the licensed PCS operators will partner with some of these manufacturers to pursue one of two strategies: Either a low-powered handset that works at low mobility both inside a building (using the unlicensed PCS bands) and outside (using licensed PCS), or a handset that works at low power and low mobility inside the building, but high power and high mobility outside.

The in-building PCS offerings at PCS frequencies that partner with wide-area licensed PCS operators will face incumbent competition from cellular providers. These cellular licensees are already offering handsets and in-building base stations for a service that operates at 800 MHz cellular frequencies, for both in-building (low-powered) and outside (normal cellular) service.

SUMMARY

The US PCS industry will feature introduction of service in 1996 from many carriers with different service packages. Since some of these packages strive to resemble automotive cellular operations, it is likely that many subscribers will see no difference between cellular operators of today and PCS operators of tomorrow. However, carriers are free to innovate, and the number of standards coupled with the number of competitors in each market ensure that some carriers will be offering US subscribers new choices for wireless service as the era of PCS matures.

PHS: A New Advanced Infrastructure for Mobile Communications and Wireless Local Loop Applications

Hideo OKINAKA
Kokusai Denshin Denwa Co., Ltd. (KDD)
Tokyo 163-03, Japan

ABSTRACT

The Personal Handy phone System (PHS) got into commercial mobile communications service in Japan on 1st July 1995. The PHS is a micro-cell wireless communication system using 1.9 GHz spectrum. It can be applied for the wireless local loop for the basic telephone service as well as mobile communications services. This paper gives an overview of PHS service deployment in Japan and its technical characteristics, and discusses the potential applications of PHS for a variety of market needs.

1. Introduction

The demand for mobile communications services has exploded in recent years in many countries worldwide. At the same time, the pace in providing the basic telephone service has been behind the speed of market growth in developing countries, though many efforts have been being undertaken by regulatory bodies and telecommunications operators.

One pragmatic way of catching up the rapidly growing market needs for the basic telephone service is the use of wireless local loop technology. A single wireless communications technology may also meet the demand for mobile communications services. PHS, The Personal Handy phone System, is a solution to such a dual application requirement, which has been developed in Japan through multinational collaboration.

The PHS is a micro-cell wireless communication system using 1.9 GHz spectrum which has been allocated to FPLMTS in WARC-92. It can be applied for mobile communications services where both call origination and termination are possible and for wireless local loop for the basic telephone service. A single PHS handy portable terminal can be used for a public mobile communications service as well as for the handset of domestic basic telephone. The PHS supports a minimum 32 kbit/s digital bearer channel to a user, thus has a potential for emerging mobile multimedia services.

The public mobile communications service using PHS commenced on 1st July 1995 in Japan and is now deployed nationwide. The PHS may also be an infrastructure for the Hong Kong's Cordless Access Services and for the U.S. Personal Communications Services (PCS).

This paper first gives an overview of PHS service deployment in Japan. It then describes technical aspects of PHS which include the positioning of PHS technology among a variety of evolving wireless technologies in the world, system features and relevant standards. It is followed by discussions on potential applications of the PHS.

2. PHS Service Deployment

2.1 Service Launch

1st July 1995 was celebrated by many Japanese customers and telecommunications industry. NTT Central Personal Communications Network Inc. and DDI Tokyo Pocket Telephone, Inc. commenced their PHS services in the Tokyo area on the day. Two other regional operating companies, one from the NTT Personal Communications Network group and the other from the DDI Pocket Telephone group also began their services in Sapporo, a big city in northern Japan on the same day.

At the end of July, only a month after the service launch, the number of connected customers to their services counted approximately 87,000 in total, where NTT Central Personal Communications Network Inc. and DDI Tokyo Pocket Telephone, Inc. gained 40,000 and 34,000, respectively, in the Tokyo area.

The NTT Personal Communications Network group expanded its service nationwide to cover major cities by remaining seven regional operating companies beginning their services on 1st October. On the same day, two operating companies from the third service group, ASTEL, commenced their services in Tokyo and Osaka areas. It is reported that the total number of PHS subscribers all over Japan counted 362,000 at the end of October 1995. As a comparison, the cellular services gained approximately 1,730,000 subscribers all over Japan during the same period from 1st July till end October.

2.2 Market Forecast

The Telecommunication Technology Council of Ministry of Post and Telecommunications (MPT) reported in March 1994 that the number of PHS mobile service subscribers in Japan will reach 6 million, 18 million and 36 million in the year 2000, 2005 and 2010, respectively.

2.3 Service Deployment

The MPT of Japan issued its guidelines for the PHS operator licence in 1994, where Japanese territory is divided into ten geographical regions and up to three licences would be given in each region. As a result, three operators have been licensed in nine out of ten regions and one operator in the remaining one region, Okinawa. Each of the three operators belongs to one of three groups, i.e. the NTT Personal Communications Network group which is heavily invested in by NTT and its subsidiary cellular and pager operating company, NTT DoCoMo, the DDI Pocket Telephone group which is heavily invested in by a domestic long distance carrier, DDI Corp., and the ASTEL group which is founded by power utility companies, railway companies and major trading companies. KDD joined the ASTEL group.

NTT Central Personal Communications Network Inc., which is a regional company serving Tokyo and its surrounding area, claimed that they installed approximately 20,000 cell stations (base stations) by Day One. Both ASTEL Tokyo Corp., which is the regional operating company of the ASTEL group serving the same area, and NTT Central Personal Communications Network Inc. stated that they will increase cell stations to count 50,000 to 60,000 by the end of March 1996. A report suggests that the NTT Personal Communications Network group intends to set up total 123,000 cell stations across Japan by end March 1996 while the DDI Pocket Telephone group, which employs cell stations of higher power or of wider coverage per station, intends to build 30,000 cell stations by the same day.

The NTT Personal Communications Network group primarily uses pay phone booths and telephone line poles for installation of cell stations, and the ASTEL group primarily uses utility poles, reflecting their primary share holders. Their cell stations are designed to feed 20 mW output power which normally gives a coverage of 100 to 300 meters in diameter according to radio propagation environments.

In contrast with these two groups, the DDI Pocket Telephone group primarily installs their cell stations of 500 mW output power on top of a few-storey buildings. This type of cell station will serve a coverage of as wide as 500 meters in diameter, thus will enable deployment of services with less number of cell stations. The NTT Personal Communications Network and ASTEL groups are both developing a 100 mW cell stations for use in the suburban area having lower traffic demand. Figure 1 shows typical installation of commercial cell stations for each group.

The tariff of PHS mobile communications service was set attractively low compared with that of conventional cellular communication services. It was rather competitive to the public pay phone tariff. The monthly PHS subscription fee is approximately 150% as high as that of the conventional NTT's home telephone service. The PHS call charge for a short distance is 133% as high as that of public pay phone service or JYE 10 higher per call. An additional remarkable point is that the connection fee to the PHS service is approximately one tenths as low as that of the NTT's basic home telephone service. Table 1 shows an example of service tariff which is issued by ASTEL Tokyo Corp. and compares it with other typical telecommunications services. The tariffs of other two groups look comparable to the ASTEL Tokyo's tariff.

2.4 Hand-Set Variety

More than 15 manufacturers have been involved in the PHS hand-set market. The NTT Personal Communications Network and ASTEL groups are selling five and six models of hand-set in their own brand, respectively. The DDI Pocket Telephone group adopts a different marketing approach where they sell a chip set to hand-set manufacturers who fabricate their products using this chip set and market their products in their own brand. Nine manufacturers are now selling this type of hand-set.

Thanks to the sophisticated PHS system design and newer technologies, the physical size and weight of PHS hand-set is much smaller and lighter and the bat-

Table 1
PHS Service Tariff Offered by ASTEL Tokyo Corp. and Its Comparison with Other Services

(Call charge: JYE/3 minutes)

	NTT's Basic Telephone		PHS ASTEL Tokyo			Cellular Typical
	Home	Payphone				
	Busy hr.	Busy hr.	Busy hr.	Home hr.	Disc. hr.	Busy hr.
Connection Fee	72,800	N/A	7,000			10,800
Monthly Subscription	1,750	N/A	2,700			7,500
Call Charge Within One Area	10	30	40	40	30	190
≤ 20 km	20	40	50	50	40	190
≤ 30 km	40	60	50	50	40	190
≤ 40 km	50	80	80	70	50	190
≤ 60 km	50	110	80	70	50	190
≤ 80 km	80	140	110	80	60	190
≤ 100 km	80	160	110	80	60	190
≤ 160 km	140	200	160	100	80	190
> 160 km	180	220	200	120	100	240

tery of PHS hand-set lasts extremely longer than those of cellular hand-set. One remarkable model from the NTT Personal Communications Network group records 95 grams in weight and 98 cc in volume at the dimension of 43 mm width x 112 mm height x 26.7 mm depth, including battery. Despite this miniature size, its talk time reaches 5 hours and the stand-by time 400 hours. This long battery life enables the use of hand-set at weekly recharging. Figure 2 shows six models of PHS hand-sets available from the ASTEL group.

The list price of a hand-set from the ASTEL group is in a range of JYE 38,000 to JYE 48,000. These prices are expected to be lowered as the production quantity increases.

2.5 PHS Deployment outside Japan

In November 1994, OFTA of Hong Kong, the regulatory body of Hong Kong, announced its licensing regulation for the wireless personal communications services using 1.9 GHz frequency band, where the category of Cordless Access Services could employ the PHS. Two licence applications which were submitted in June 1995 in response to this decision are reportedly said to adopt the PHS. This could result in the first deployment of the PHS technology outside Japan.

In addition to the possible adoption of PHS in Hong Kong, PHS was also accepted by Singapore for the cordless PABX application. Various efforts are being undertaken by many organisations to deploy the PHS technology in the Asia-Pacific region, which includes on-going and/or planned trials or demonstrations in e.g. Malaysia, Indonesia, China and Thailand. KDD is conducting a trial in Thailand, where 22 cell stations are connected to a PHS-based PABX to serve the whole space of a four-storey building.

In order to foster implementation of the PHS outside Japan, foundation of the PHS MoU group is now being pursued and a preparatory MoU group has already begun its activities. The secretariat of the preparatory MoU group resides in The Association of Radio Industry and Businesses (ARIB), Tokyo, Japan.

3. Design Concept and Technical Aspects

3.1 PHS Design Concept

The idea of PHS came from the desire to use a single portable hand-set at and outside home for the domestic wireline basic telephone service and for the public mobile telecommunications service, respectively. Offering a mobile communications service at much inexpensive charge compared with the conventional cellular service was another significant objective.

Based on these starting point, the PHS has been designed to achieve the following characteristics.

- Call connection to anyone, at any time and anywhere
- Common air interface for home, office and public outdoor uses
- Pocket-sized portable communicator

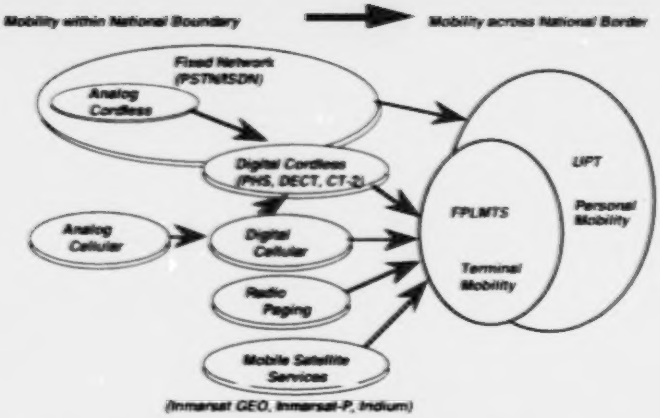

Mobility within National Boundary
Mobility across National Border
Fixed Network (PSTN/ISDN)
Analog Cordless
Digital Cordless (PHS, DECT, CT-2)
Analog Cellular
Digital Cellular
Radio Paging
Mobile Satellite Services
(Inmarsat GEO, Inmarsat-P, Iridium)
FPLMTS
Terminal Mobility
UPT
Personal Mobility

Figure 3 PHS Positioning in Technology and System Evolution

- Longer communicator's battery life
- Higher system capacity than cellular systems
- Higher speech quality than cellular systems
- ISDN-comparable bearer data capability
- Low call charge and monthly subscription fee for mobile services

3.2 PHS Positioning among Mobile System Standards

The mobile communications technologies and system standards are now rapidly evolving in the world. It will be appropriate to understand that we are now in the era of the second generation where technologies have moved from analogue to digital. We need yet evolve further to the third generation era where integrated mobility and services will be realised including world-wide international roaming.

Figure 3 depicts the evolution of mobile communications technologies and systems. The technology base is changing from analogue to digital and the mobility is expanding from within national boundary to across national border. As indicated in the figure, the PHS can be characterised as the second generation digital-based system which provides both the cordless capability for domestic use and the public mobile service features. An European standard, DECT, and a North American system, PACS, are targeting the similar goal.

Table 2 compares the PHS with cellular systems. As seen in the table, the PHS pursues provision of better speech quality at the cost of less acceptability of mobility speed while, as an overall, targeting less expensive tariff, compared with the cellular mobile communications services.

3.3 PHS System Features and System Elements

In order for the PHS to offer a secure wireless communications and to meet mobility requirements, it provides the following system features.

- Location registration
- Authentication
- Call origination
- Call termination
- Handover
- Roaming
- Direct PS-to-PS communication (handy talkie)

These system features are generally implemented by means of several network elements, i.e. Personal Stations (PS: user hand-set), Cell Stations (CS: network base station), switch, database storing user location and authentication data, and operation and maintenance (O&M) centre.

Table 2 Comparison of PHS with Cellular

	PHS	*Cellular*
Coverage/Cell Stn	Smaller (100-500 m)	Larger (1.5-10 km)
Cost/Cell Stn	Inexpensive (by factor of a few 100s)	Expensive
Acceptable Mobility Speed	Medium (Pedestrian use)	High (Automobile use)
Speech Quality	High (comparable to fixed services)	Moderate
Data Transmission Capability	More suitable	Limited in data rate
User Tariff	Cheap	Higher than PHS

3.4 PHS Air Interface

The PHS common air interface was developed and standardised, through multinational collaboration, by a Japanese radio system standardisation body, RCR, which has become ARIB. The specification is publicly available in the form of RCR Standard-28 issued by ARIB.

Table 3 shows major parameters of PHS common air interface specification. The PHS is a micro-cell digital-based system using 1.9 GHz frequency band. A worth-noting design that should be pointed out is the use of dynamic channel assignment based on carrier sensing. Because of this feature, the PHS does, unlike cellular communications systems, not need channel frequency planning to avoid interference with the adjacent CSs, and a common pool of frequency sets can be shared even among multiple independent PHS networks. Another feature to be highlighted is the adoption of the time division multiple access with time division duplex (TDMA/TDD) technology, whereby up to 256 kbit/s bearer channel could be provided at no extra requirements for transceiver and transmitter power at both PS and CS.

Table 3
PHS Common Air Interface Specification

Frequency Band	1.895 - 1.9181 GHz
Carrier Frequency Separation	300 kHz
Access Method	TDMA/TDD
Number of Channels/Carrier	4
Modulation Method	$\pi/4$ Shift QPSK
Transmission Power	10 mW average (PS) 10 mW average (non-public CS) 500 mW max (public CS: typically 20 mW average)
Modulation Bit Rate	384 kbit/s

3.5 PHS Network Interfaces

A set of standards for network interfaces is provided by a Japanese wireline system standardisation body, Telecommunications Technology Committee (TTC), for implementation of the PHS. The current set of standards covers the CS-to-switch interface and the switch-to-switch interface and is largely based on the ISDN and Intelligent Network (IN) technologies. Table 4 shows the list of standards relevant to the PHS network interfacing.

The CS-to-switch interface is called the I'-interface which is an expansion of the ISDN basic rate interface. The I'-interface supports the features of location registration, authentication and handover, and realises essential network capabilities of the PHS such as PS number notification and paging based on a group of cell stations. The switch-to-switch interface accommodates the capabilities required for roaming and uses the IN technology.

Table 4
Standards for PHS Implementation

Standard	*Description*	*Features*
RCR STD-28	Common Air Interface	PHS Air I/F
TTC JT-Q 921b	Limited version of ITU-T Q.921	Layer 2 of CS-Switch I/F
TTC JT-Q931b	ITU-T Q.931 *plus* TTC supplements	Layer 3 of CS-Switch I/F: Paging
TTC JT-Q932a	ITU-T Q.932 *plus* TTC supplements	Layer 3 of CS-Switch I/F: Loc. Reg., HO, Auth.
TTC JT-Q1218	ITU-T Q.1218 *plus* TTC supplements	Basic IN for Switch-Switch I/F
TTC JT-Q1218a	TTC supplement to ITU-T Q.1218	PHS Capability of IN for Switch-Switch I/F: Roaming

4. PHS Applications and Implementations

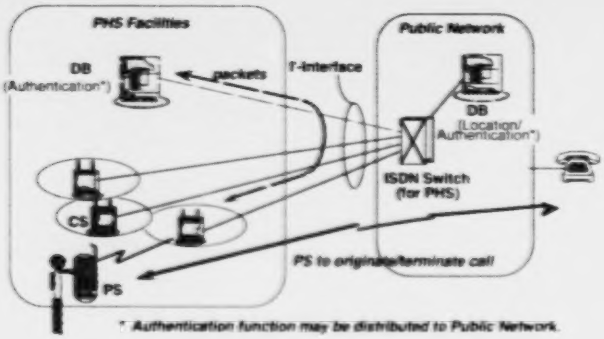
4.1 Public Mobile Services

Although deployment of an all-in-one PHS network, which is connected with the public telephone networks, is a natural approach to introduction of the PHS service, the PHS network can also be implemented by using some of the capabilities available in the local ISDN network.

Figure 4 demonstrates a typical example of PHS network configuration using the ISDN facilities. In this configuration, all of the network functions, including location register and authentication centre, are prepared by the ISDN operator, and only cell stations (CS) are provided by the PHS operator. Optionally, the authentication centre may be distributed to the hand of PHS operator for security reasons. In fact, Japanese PHS operators, with exceptions of a few regional companies from the ASTEL group, employ this approach where the ISDN and the location registration database are provided by NTT.

The PHS operators of this network configuration are paying a call-by-call-based access charge to NTT which includes the cost of provision and use of the database and the I'-interface ports for connection of the CSs.

Only a few regional companies from the ASTEL group adopted the all-in-one PHS network approach for their service deployment. Although this approach requires



* Authentication function may be distributed to Public Network.

Figure 4 Public Network Dependent Implementation of PHS

heavy investment to the PHS operators at the beginning, it is expected that the burden will be eased more rapidly than the PHS operators relying their services on NTT, the ISDN provider.

4.2 Office Cordless PABX System and Domestic Cordless Telephone

Since the PHS is designed to support the mobile communications service with high speech quality, application of the PHS technology to an office cordless PABX system is a natural extension. Several Japanese manufactures have already been selling such systems. The hand-sets (PSs) for such PHS-based PABX systems can be brought out of the office for access to the public PHS services. Some of products further offer the roaming capability between two remote PABX networks.

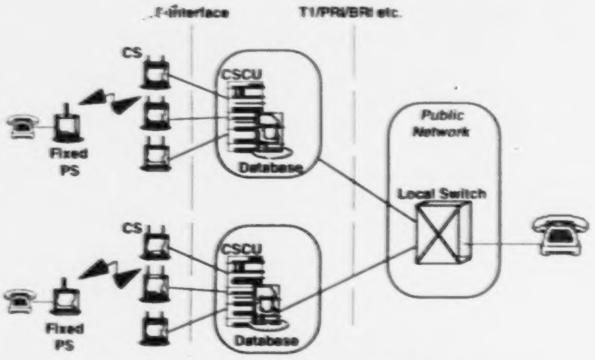
Several manufactures of PHS PSs are also selling domestic telephone adapters which operate as a CS for domestic cordless telephone use. With this adapter installed at home, customers can enjoy a cordless environment at normal basic telephone tariff at home while receiving public mobile communications services outdoors.

4.3 Wireless Local Loop

The wireless local loop (WLL) may be attractive when there is a huge back-log of orders for subscriber loops because of shortage of existing wire lines or because laying new wire lines down is costly due to surrounding circumstances.

Since a PHS cell station (CS) can support three traffic channels by two pairs of metallic cables from a local switch of ISDN network, the PHS could be a means to realise the WLL in the area having high traffic density and less number of wire lines. The PHS as the WLL means could also be applied to newly developed residential areas where a large number of local loops will be needed at a time. The WLL deployment by the use of PHS has an advantage that the network could evolve to a mobile service network at affordable extra cost in the later year when customers demand such a service.

An example network configuration of WLL using PHS is depicted in Figure 5. In this configuration, a cell station control unit (CSCU) at remote sites is used between the local switch of basic telephone network and the CSs, whereby the CSs and the local switch can be connected with the CSCU by the I'-interface and any kind of interface, respectively. Because of the adoption of I'-interface at CSs, off-the-shelf CSs which are available for the public PHS services and thus at lower price due to volume production can be used for this application. The CSCU also performs authentication of PSs which make access to the network. The network is upgradable to a mobile service network by implementing the mobility management capability in the CSCU.



CSCU: Cell Station Control Unit

Figure 5 PHS Application: A Wireless Local Loop Example

The PS can be replaced by a purpose-designed personal station which may provide an increased transmission power and/or which may use an antenna of higher gain. By doing so, the coverage of a cell station are enlarged.

4.4 PHS Networking on CATV

The CATV cable may have an extra bandwidth available for other applications. If an extra capacity of

CATV cable is used for connection between CSs and a PHS switch, a PHS network could be deployed at low cost.

Figure 6 shows a configuration of PHS network over a CATV network. A channel on the CATV cable will be shared by a number of CSs by adopting appropriate multiple access technology such as TDMA.

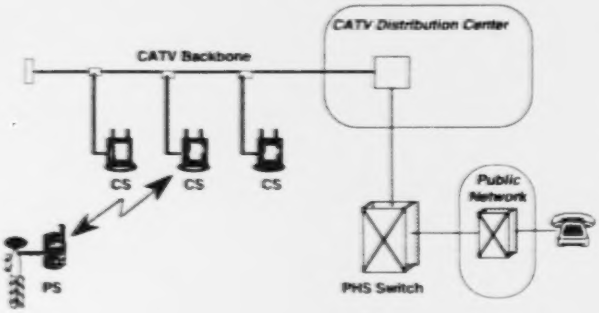


Figure 6 PHS Application: PHS Implementation on CATV

KDD has conducted an experiment of such PHS networking in collaboration with Tokyu Cable Television, Inc. in order to verify feasibility of the PHS deployment over CATV networks. The result of this experiment was encouraging and demonstrated that the high speech quality was maintained despite the relatively noisy condition of uplink.

4.5 Wireless Multimedia Applications

The PHS uses a 32 kbit/s bearer channel for basic communications and can virtually offer up to a 128 kbit/s bearer channel by assigning four 32 kbit/s channels on a single radio channel taking advantage of TDMA/TDD technology. Although the method for interconnecting bearer data channels over the air with the ISDN basic rate interface at the CS has yet to be standardised, efforts are being undertaken by standardisation bodies to realise, at first, 32 kbit/s bearer services. Figure 7 depicts an image of such a data service. In the event of completion of this work, customers will enjoy a high bit rate ISDN-alike services which may be used for the WWW access over Internet through PHS and so on.

Prior to completion of the standardisation, the PHS can be used for data communications by means of voice band data modem, because, unlike digital-based cellular systems, the PHS adopts 32 kbit/s ADPCM which is transparent to the voice band data.

Manufacturers are making efforts to develop a PHS hand-set which is capable of supporting multimedia applications. A product now on the market has a wireless optical interface which may be connected with the PDA. The PS implemented in a PCMCIA card has also been reported. By this PCMCIA card, personal computers could be easily connected with the PHS service once the data capability becomes available in the PHS network.

5. Conclusion

The public PHS service has successfully been launched in Japan. The rapid growth of the number of subscribers in Japan will result in the rapid decline of the retail price of terminal due to volume production, which will further stimulate new subscriptions. There is a sign that PHS may be deployed outside Japan, in particular in the Asia-Pacific region.

The PHS is an advanced digital technology-based telecommunications system with a great potential for a variety of applications. It can be used for the public mobile combinations service, the office cordless PABX system, domestic cordless telephone apparatus, an infrastructure for an ISDN-alike mobile multimedia data services and so on.

Due to its huge potential service capabilities, the PHS is expected to become a mainstream of the cordless access means in the world.

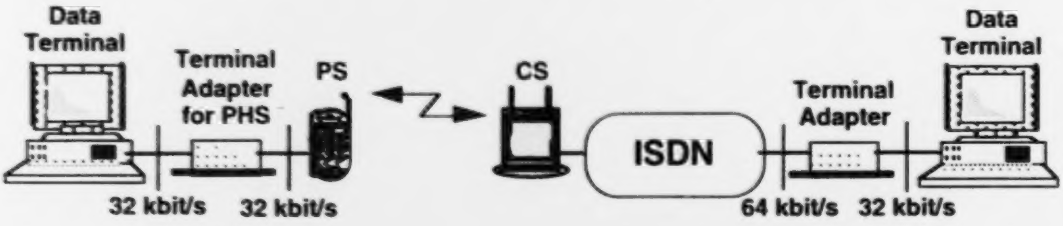
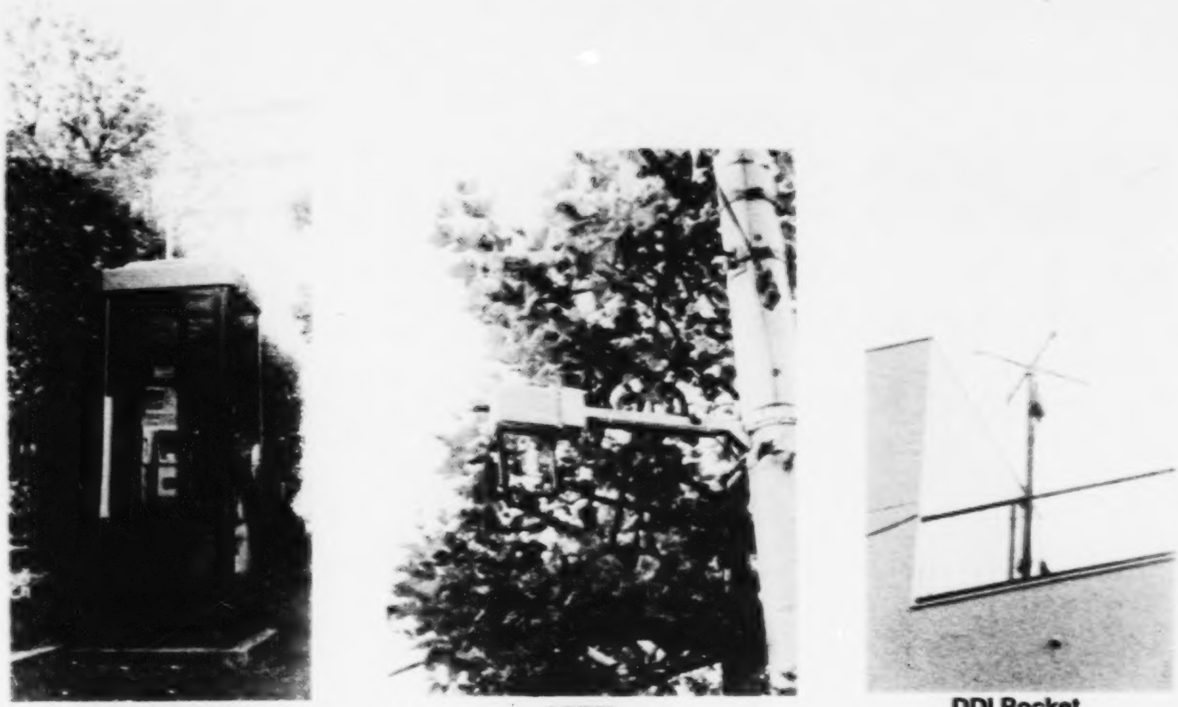


Figure 7 PHS Application: ISDN-alike Mobile Data Service



NTT Personal
(Pay Phone Booth)

ASTEL
(Utility Pole)

DDI Pocket
(Building Roof)

Figure 1 Typical Installation of Cell Stations

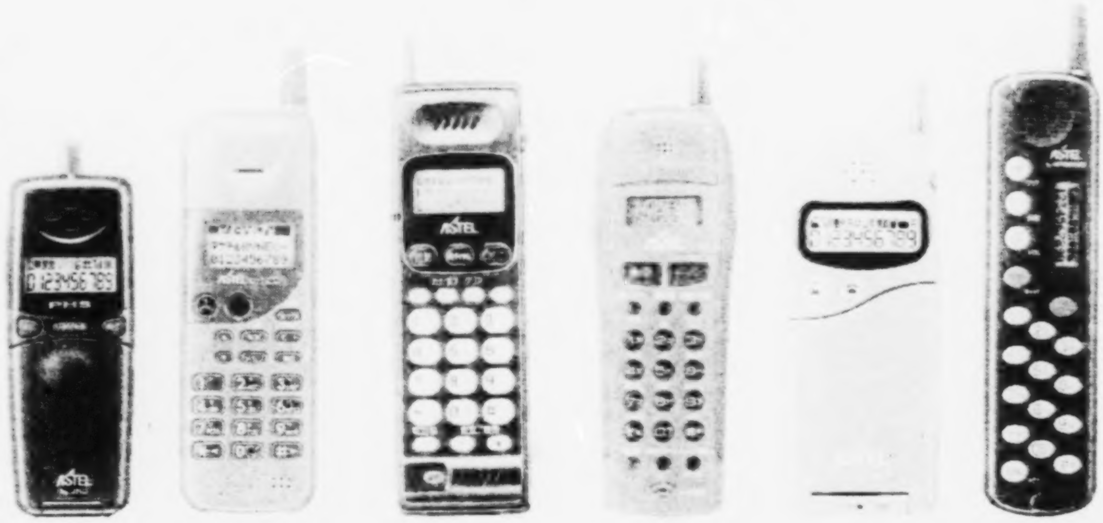

0123456789
PHS
ASTEL
ASTEL
0123456789
ASTEL

Figure 2 Hand-Set Line-up from the ASTEL Group

REGULATORY ASPECTS OF AN INTERNATIONAL PCS SATELLITE SYSTEM

Dr. Edward R. Slack
COMSAT Mobile Communications
Bethesda, Maryland, USA

1. ABSTRACT

Many industry experts believe that Resolutions 46 and 70 of the 1992 World Administrative Radio Conference provide the underlying authority for regulation of International PCS Satellite Systems. While this is true, in fact there will be a number of other factors influencing such regulation, and therefore may result in differences in the way many countries will implement service. This paper examines the concerns of telecommunications authorities and how they may be expected to react to the many proposals advanced.

2. PCS SATELLITE PROPOSALS

2.1 NATIONAL, REGIONAL AND GLOBAL SYSTEMS

There has been a plethora of proposals for Mobile Satellite Service. Some of the national systems have been proposed to expand the capability of the domestic infrastructure of an individual country, such as the OPTUS system in Australia; AMSC's USA system; Telecomunicaciones de Mexico's Solidaridad system; and TeleSat's Canadian proposal. Regional systems include the Asian MSS proposals such as the Garuda and Agrani partnerships and Asia Pacific Mobile Telecommunications. Lastly, the global networks include Globalstar (Loral), Iridium (Motorola), I-CO Global Communications, Odyssey (TRW), as well as the not yet authorized Elipso system. The national and regional systems rely primarily on geostationary (GEO)satellites, while the global systems are using technology based upon the use of low earth orbiting (LEO) or medium or intermediate earth orbiting (MEO) satellites. As markets and strategies develop, we can expect to see many of the national systems evolve into regional systems.

2.2 HERITAGE

All of the national systems described in 2.1 above have been authorized by the national regulatory bodies for the countries in which the systems are to be deployed, and regional systems by the lead country of the group of countries to be served by the proposed system(s). The international systems, with the exception of the IC-O system, have all been proposed by U.S.-based companies, which has been the basis of many of the criticisms of those networks, with the detractors arguing that the Federal Communications Commission (FCC) of the United States is unilaterally imposing its will on the world and pre-empting other systems from developing.

In terms of technology, the vast majority of the networks will employ satellites manufactured by U.S. satellite manufacturers. This also has the effect of giving competitive advantages in the development of technology to producers from the U.S., again causing concern by governments who would otherwise be expected to support domestic manufacturers.

3. HISTORICAL DEVELOPMENT

3.1 MARISAT/INMARSAT

Commercial mobile satellite communications began in 1976 with the launch of COMSAT's MARISAT system, which piggy-backed upon a U.S. Navy system an L-Band payload to provide for service to ships at sea. This evolved into the formation of the International Maritime Satellite Organization (later changed to International Mobile Satellite Organization), an international system owned and operated by a consortium of 78 countries.

The role of the system expanded to include both land mobile and aeronautical services as the need for mobile satellite communications developed. Although land mobile service holds the greatest prospect for service growth, it has been hindered by both regulatory restrictions and lack of regulations in many countries. A key component of the regulatory process has been opening the borders of a country to permit foreigners to use service on both a short term and a long term basis. Use on a short term basis is usually referred to as transborder service which normally requires an operating license while maintaining the registry of the equipment in the home country of the user, while long term operation is considered purely a licensing matter, but requiring registry in the country in which used. This has been compounded by concerns based upon a variety of factors, including national security and revenue by-pass of existing national networks. The importance of this is that the Inmarsat experience points out the problems which any global system might expect to encounter.

To date, the Inmarsat service has been limited and therefore not a serious threat to the viability of national telecommunications administrations. This has been due to the high cost of equipment and service. At present, all of the Inmarsat technologies account for a small number of users, as shown as of the end of October 1995.

Technology	Maritime Users	Land Users	Total Users
Inmarsat-A	17,807	7,595	25,402
Inmarsat-B	481	797	1,278
Inmarsat-M	1,384	5,855	7,239
Inmarsat-C	12,759	7,328	20,087

Inmarsat-A was the original MARISAT technology which provided analog voice service, and was developed for maritime users. The later technologies were based upon digital techniques, and resulted in lower equipment and service costs. With the exception of Inmarsat-C (a store and forward data service) the technologies all permit voice as well as data and facsimile service. As can be seen above, the number of land users also became more of an important market factor, leading to the interest of the various domestic, regional and global systems identified earlier.

The first mass-market technology will be introduced by Inmarsat in mid-1996 with the start of Inmarsat Mini-M service, which will be marketed by COMSAT as its Planet One(TM) service. This service will result in the deployment of much lower priced user equipment (approximately US$3,500) as well as lower priced service (between US$3.00 -4.00 per minute), and is expected to attract several hundred thousand land-based users. Plans call for the later terminals to be cellular-compatible, similar to the plans for most of the PCS systems. This will provide for a greater test of the regulatory process and distribution and servicing networks.

3.2 DOMESTIC SYSTEMS

Domestic services are now in the process of being introduced. AMSC will begin its service this year in the U.S. and has established a marketing strategy of operating through resellers rather than serving end users directly as is done by Inmarsat system service providers. At present, users of the AMSC service will be limited to purchasing equipment made by two manufacturers authorized to provide equipment to operated through the system. This contrasts with the Inmarsat system in which the user equipment specifications are available to any potential manufacturer, who must submit its equipment for testing for acceptance into the network. Both the Canadian and Mexican domestic systems are also expected to become operation in 1996, and employ similar technologies.

4. GLOBAL REGULATIONS

4.1 The ITU and the 1992 WARC

Under the International Telecommunications Union (ITU), individual countries have the right to authorize communications services and to license users. Exercise of this right is usually accomplished through the Ministry of Communications or its equivalent. This was re-emphasized in the decisions of the 1992 World Administrative Radio Conference in two key resolutions:

Resolution 46 grants to Members of the ITU the specific right to regulate access to a system from their territory, and obliges satellite network operators to abide by national laws where they deliver service. The national authorities may require operators to obtain satellite network licenses in addition to a specific right to provide a service in each country to be served.

Resolution 70 g)draws attention to the fact "that CCITT Recommendations provide for the apportionment of accounting revenues on international traffic between terminal countries, in principle on an equitable basis". This Resolution also recommends that studies be undertaken to ensure equitable and standard conditions of access for all countries. With the large number of proposed systems, and different technical and operational approaches for service, it becomes very difficult to expect that the latter part of this resolution will have any meaningful impact.

4.2 THE 1995 WORLD RADIO CONFERENCE (WRC)

The 1995 recently concluded WRC provided results very favorable for the MSS services, advancing the use of 2 Ghz worldwide bands for MSS from the year 2005 to January 1, 2000, with tropo operations in the bands to be discontinued by the year 2000. Additional progress was made on the use of the extended band for MSS at 2010-2025 MHZ for use in Region 2 (Americas) to become available in the year 2005; feeder link bands at 5 and 7 Ghz adopted with sufficient bandwidth and power limits; and completion of all necessary studies and arrangements for use of the new FSS band at 13.75-14.00 GHz adopted.

4.3 OTHER FACTORS AFFECTING THE REGULATORY PROCESS

The European Commission (EC) received from KPMG Peat Marwick a report in March 1994 entitled "Satellite Personal Communications and their Consequences for European Telecommunications, Trade and Industry", which outlined the consultants' recommendations as to how the European Commission might respond to the various PCS proposals authorized by the FCC. The countries of the European Union (EU) were not concerned so much by the prospects of the amount of traffic which might be diverted to a global PCS system, since the European domestic telecommunications networks are substantially developed and inexpensive, and a regional Mobile Global System (GSM) based on cellular technologies was already in place. The EU was recommended to focus itself on developing a regional set of principles of regulation designed to protect EU industry and investment opportunities. This included tariffing principles, interconnect agreements and regulation for all elements of the service, as well as development of specifications to permit competition in the supply of all interfaces necessary to interoperate ground equipment, including handsets. The report also placed emphasis on infrastructure using a concept of gateway licensing for European traffic. This approach, which included use of the Conference Europeenne des Postes et Telegraphes (CEPT), the European Committee of Telecommunications Regulatory Agencies (ECTRA) and the European Radiocommunication Committee (ERC) to continue efforts to protect the various European interests as might be identified.

5. TRANSBORDER SERVICE

5.1 REGIONAL EXPERIENCE

The Inmarsat Organization has undertaken a series of efforts to obtain regional agreements designed to permit transborder use of its communications services by users traveling from one country to another, encouraging the countries of a region to allow users from other countries in the region to operate equipment in each other's country without the need to obtain additional operating licenses. To date, only the CEPT countries have been able to reach agreement for Inmarsat-C equipment in principle and Inmarsat-M land mobile equipment. A test of the CEPT agreement in 7 member countries for Inmarsat-C service revealed that only 2 of those countries permitted open use, another 2 required individual licenses, and 3 refused to grant approval. It was learned that one of the reasons for refusing to grant permission was a competing land-mobile satellite data system had been authorized in one of the countries solicited.

One of the problems with the regional agreement concept is that most users needing access for service will be from a different region of the world (visitors from developed countries visiting underdeveloped countries), and thus the regional agreement will not cover the application.

397

5.2 GLOBAL EXPERIENCE

Inmarsat has been able to obtain agreement for a somewhat limited version of transborder service for maritime use in ports and harbors, wherein regulatory authorities may authorize service on a unilateral, bilateral or multilateral basis.

More recently, the CCITT has recommended that Administrations permit satellite news gathering (SNG) units be permitted open access for taking their units into and out of countries for their reporting purposes. The effect of this recommendation are yet to be learned.

6. REGULATORY ASPECTS

6.1 FREQUENCY AUTHORIZATION

Under the Radio Regulations, countries can restrict the use of certain frequencies for various applications. One of the problems in the Inmarsat system was that many of the East European countries restricted the use of the L-Band frequencies for use of radar systems, thereby creating a potential interference problem and resulting in the denial of licenses to operate the user terminals. This problem is generally being eliminated and is not expected to be a continuing problem.

6.2 SERVICE PROVIDER

The movement towards privatization, deregulation and competition have resulted in removing some services from the traditional monopoly of the national telecommunications administration (PTT) and permitting them to be offered by new entities. This is particularly true for the mobile services, which have been viewed as ancillary to the development of a national telecommunications system rather than competitive to the PTT, which usually subsidized local and domestic long distance service from international revenues. Many of the developers of global PCS satellite systems have entered into arrangements with the traditional PTTs or newly established entrepreneurs which have the responsibility to obtain operating licenses for the services. This strategy has also been true for cellular licenses, and demonstrates the importance of having local participants in the service.

6.3 LICENSE FEES

Many countries have established prohibitive licensing fees as a means of discouraging mobile satellite service and as a means of protecting the revenue stream of the PTT. This is accomplished in a variety of ways, either through the license itself, the establishment of surcharges on communications services, etc. Sometimes, the Administration would set the value of the license at the equivalent of charges for a full period international leased circuit. The effect of such charging mechanisms has been to restrict service, impacting the country by delaying development of industry or natural resources.

6.4 SECURITY ISSUES

Developing countries without democratic form of government have exercised restrictions on the development of mobile satellite service. Concerns exist as to who might have access to unmonitored communications and how much harm might result to the Administration in power. Foreign companies which will help develop the country and create jobs and investment opportunities are often more likely to receive permission for service than local citizens.

6.5 DOMESTIC COMPONENT

In order to control foreign exchange requirements, some governments have imposed restrictive import tariffs which have the effect of reducing demand for new technologies. This protectionistic attitude can result in illegal use of service or the seeking of alternative means to obtaining equipment. Many industries have been able to set up manufacturing/assembly plants in free trade zones in order to reduce the amount of such taxes. Some of the global PCS systems have contracted for satellite launches in countries where they hope to obtain licenses to provide service.

6.6 TARIFFING PRINCIPLES

One of the strongest incentives to obtaining a license to provide PCS satellite service in a country is to show that domestic service can be provided at a reasonable price. This is a strong indication to the government of those countries that the purpose of the service is not to cream skim the high revenue stream generated by international service away from the existing international service provider. A serious difficulty with this approach is that it may actually cost more to provide this service because the base station for providing service may not be located in that country, and international land line charges will be incurred to deliver the service.

6.7 NUMBER OF SYSTEMS

The number of proposed global PCS satellite systems creates additional issues to an Administration seeking to establish a policy for such service. Not all system providers may be seeking to provide service in a particular country. The Inmarsat organization is committed to a policy that there should be non-discriminatory access to national markets for all mobile satellite communications networks subject to national policy and spectrum coordination and availability. Each national administration must resolve these issues for their own country.

6.8 INTERCONNECTIVITY AND COMPATIBILITY

None of the global contenders for PCS service claims to be compatible with the others. Yet, there should be no technical reason why service through one system cannot be connected to another of the systems. The reasons may be purely economic or political.

6.9 TIMING

The need for establishing regulations may not seem imperative to many countries if service is considered to be many years in the future. However, it is important to understand that the system service providers need sufficient lead time to permit them to establish the distribution channels and local infrastructure in a country to enable them to provide service.

7. EXPECTATIONS OF REGULATORY AUTHORITIES

7.1 DEVELOPED COUNTRIES

Developed countries may be those where service is least required, but are expected to be the first to approve regulations for global PCS service. This is because they will seek to establish advantages for their domestic industries, and they view service as no real threat to the existing infrastructure. This will be the case in Europe and other regions where local manufacturers and investors stand to benefit from the establish of opportunities beyond the borders of those countries.

7.2 DEVELOPING COUNTRIES

These regions will be slower to establish regulations, and will often have to be encouraged to authorize service by local entrepreneurs who want to participate in the proposed systems. Part of the reason for delay is to examine the policy-making approach taken by the developed countries and determine the relationship of that process to their own countries. Another reason may be the expectation that the service will have very little demand and is therefore unimportant to them. A third explanation is the concern over security and revenue by-pass issues and the perceived need to avoid these perceived problems. An additional consideration is the question of urgency associated with the proposed service(s) and the need to take early action.

8. CONCLUSIONS

Most of the proposed global PCS satellite systems have stated their intentions to be operational by 1999, with some system operators expecting to begin limited operations in 1998. In order to permit timely access to the markets envisioned, substantial preparatory effort is required, and therefore concentrated efforts must be taken in those countries where the operators believe the greatest opportunities to exist to begin development of those markets. Such action will also have the effect of signaling other countries that momentum has been achieved and it is time for them to join in the service. Perhaps of assistance to all potential system operators may be the experience of the forthcoming Planet One (TM) Mini-M service, which will face many of these same problems and may result in early implementation of solutions.

Advanced Technology In DAMA Networking

Mark Dankberg
ViaSat, Inc.
Carlsbad, CA. USA

1. Abstract

Demand Assigned Multiple Access (DAMA) improves satellite network connectivity and resource utilization efficiency. But, there can be very significant differences in the degree of resource usage efficiency between different DAMA systems. This paper describes specific technical features that influence efficiency and shows the impact of each. The net result is that there may be as much as an order of magnitude difference in how effectively different DAMA systems use satellite transponders.

2. Introduction

Demand Assigned Multiple Access (DAMA), also sometimes called bandwidth on demand, is an increasingly popular technique to improve connectivity and efficiency of time varying mesh satellite networks. Thin route mesh telephone networks primarily use Frequency Division Multiple Access (FDMA) to minimize throughput delays and earth station complexity. While even simple DAMA management offers substantial gain over fixed or manually configured links, advanced technical features may offer dramatic additional improvements. Example features include frequency pre-correction, fine frequency channelization, adaptive power management, voice activation, and advanced modulation and coding. Technology benefits can be quantitatively measured in terms that are important to satellite users. For instance, service providers can see substantial improvement in the number of simultaneous active voice calls per transponder. The paper presents a technical overview of each of these key technologies. This includes the underlying technical issues and their associated performance impact. Then, representative Asia Pacific satellite configurations and traffic models illustrate the effective gains due to each technique. Incremental performance gains depend on a number of factors, including frequency band, transponder specifications, ground terminal equipment, and offered user traffic. The number of simultaneous active services can be either band limited or power limited. The combination of technical features works to push both these boundaries, resulting in significant increases in subscribers per transponder.

The first part of the paper reviews some of the basic technical aspects of thin-route FDMA DAMA networks. We describe the technical issues concerning bandwidth and power consumption and the concepts of band limited and power limited systems.

Then we consider a representative example for a DAMA network using THAICOM 2 K_u band. We show how the application of each successive layer of technology influences the balance between band limiting and power limiting. The final result shows greater than an order of magnitude difference between the simplest bandwidth on demand type controller and a more sophisticated DAMA system. The conference presentation includes graphical depictions of the data, plus a unique inter-active demonstration of the DAMA network configuration tool that shows how the different technologies combine to optimize system capacity.

3. Technical Issues

The basic purpose of adding Demand Assignment Multiple Access (DAMA) to satellite networks is to improve economics. Dedicated Single Channel Per Carrier (SCPC) or Multi-Channel Per Carrier (MCPC) network configurations can provide the same functions as a DAMA network. Fixed assigned networks are just much more expensive than DAMA networks. They require more ground terminal equipment and more transponder resources. It is useful to compare DAMA systems quantitatively. A critical measure is the number of active circuits that can be supported per satellite transponder. This is a simple metric to determine how effectively the DAMA system manages available resources. It combines the consequences of the Multiple Access method with the Demand Assignment protocols. The remainder of this section of the paper considers the factors that constrain the number of DAMA subscribers and show the benefits of advanced technologies.

3.1 Transponder Resource Management

The two key resources on a satellite transponder (or transponder segment) are downlink power and bandwidth. Each user service consumes some fraction of these resources. When the traffic demand exceeds available resources, users are denied service, or service quality degrades below specified standards. For simplicity we consider a single digital voice or data circuit service offering, but the analysis concept is easily extended to a heterogeneous mix of user services.

Consider that a total of W Hz of bandwidth is available on a leased transponder, with P Watts of useable downlink EIRP (including spatially varying downlink antenna gain). The useable downlink power is less than the maximum downlink EIRP by a back-off allocation. We assume that user traffic circuits are established between time varying pairs of subscriber terminals from a population of N. For simplicity, we assume each conversation is digitized voice requiring W_i Hz. Then the maximum number that can be simultaneously served (assuming the bandlimited case) is $N_w = \frac{W}{W_i}$. The maximum number may be reduced by frequency guard bands and/or the tuning resolution of the terminals. We can also compute a "weighted" average source destination pair. This takes into account the variations in traffic patterns among {source:destination} terminal pairs, and their associated nominal link budget variations due to uplink and downlink satellite antenna gains, terminal EIRP and G/T, and nominal rain fade allocations. Assume that the satellite downlink power used for the weighted average link is P_i Watts. Then the maximum number of links that could be simultaneously served (power limited case) is $N_p = \frac{P}{P_i}$ If $N_w < N_p$ then the system is bandlimited, i.e. all of the available bandwidth has been used, when there is still some power available. If $N_p < N_w$ then the system is power limited. The best case is when they are approximately equal, so neither bandwidth nor power is "wasted". The following sections describe some of the DAMA system parameters that determine network capacity.

3.2 Frequency limitations

The following attributes determine the bandwidth required for each user circuit. We will focus on digitized voice (telephony).

3.2.1 *Digitized voice rate*

Each voice circuit is digitized with a vocoder. Lower data rates require less bandwidth, as well as less power, at the cost of greater complexity. Candidates include ITU G.726 or G.727 (32 kbps), G.728 (16 kbps) and G.729 (8 kbps) vocoder standards.

3.2.2 *Modulation type and filtering*

QPSK (and OQPSK) modulations can provide twice the bandwidth efficiency of BPSK without increasing power consumption. But quadrature modulations are much more sensitive to close in phase noise than binary. This can be a significant problem for relatively low data rates (less than 16 kbps) at satellite RF frequencies (C or K_u bands). Even when the source and destination ground terminals use converters with low close-in phase noise, the phase noise due to transponder frequency translation may degrade BER vs. E_b/N_o performance significantly. QPSK is preferable when the performance loss due to phase noise is acceptable. At low vocoder data rates this requires special digital signal processing.

Another important factor is the filtering used with the selected modulation. A key metric is frequency spacing for carriers with the same data rate and power level. Carrier spacing at 1.4 times the channel symbol rate is considered bandwidth efficient.

Finally, waveform filtering is also a factor in spectral regrowth with non-linear power amplifiers. This can be a factor for single channel terminals.

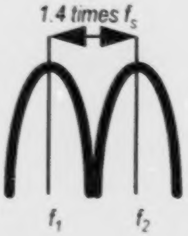


Figure 1 - Typical "Ideal" Spacing

3.2.3 *Uplink uncertainty*

Low cost telephony terminals often have imprecise reference standards. Low cost reference accuracies are on the order of 1 ppm (part per million). Without calibration, this drifts further over time. At K_u band, this imparts a transmit frequency uncertainty of as much as 14 kHz. That means the a frequency guard band of ± 14 kHz is required around each carrier to ensure that it does not overlap into the adjacent carrier. Note that for an 8 kbps vocoder, with QPSK and R=1/2 coding, the frequency reference uncertainty alone can more than double the bandwidth needed per voice circuit.

Advanced DAMA systems compensate for uplink frequency uncertainty via automatic pre-correction software. This estimates the time-varying uplink error and pre-corrects the transmission to compensate for it. The error cannot be completely eliminated, but should be reduced substantially.

3.2.4 *Forward Error Correction*

The FEC technique trades power for bandwidth. Flexible networks select an FEC code rate (e.g. $^{1}/_{2}$, $^{3}/_{4}$, $^{7}/_{8}$, etc.) to balance power and bandwidth consumption, depending on the link budgets and {source:destination} terminal pair.

3.2.5 *Fine frequency resolution*

DAMA resource allocation algorithms must use an addressing system to precisely define the nominal center frequency for each traffic circuit. The amount of transponder bandwidth reserved for the service depends on both the resolution of the addressing scheme, and the resolution of the frequency synthesizers (tuners) at the source and destination terminals. For instance, 8 kbps OQPSK voice circuits, even with uplink pre-correction, would still be spaced at 22.5 kHz intervals if that is the finest RF tuning or center frequency addressing resolution.

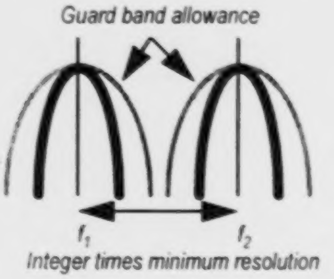


Figure 2 - Practical spacing

3.3 Power limitations

The following attributes are the primary drivers for the power required for each circuit.

3.3.1 *Transponder back-off management*

Transponders operated with FDMA must be "backed-off" - i.e. operated at a power level reduced from the saturated output. Back-off must be sufficient to reduce "intermodulation products" due to FDMA carriers to a level that does not degrade link quality below specified levels. Typical back-offs are in the range of 3 to 5 dB. That is the DAMA system must be designed to ensure that the aggregate uplink power at the satellite results in no more than 33% to 50% of the saturated transponder power amplifier (PA) output. The goal is to get as close as possible to the desired operating point, without exceeding it. "Open loop" load management systems estimate transponder PA output power based on nominal {source-destination} pair link parameters, plus link margin allocations based on rain-fade models and specified availability. Since there is no real-time feedback mechanism, open loop systems often require an "estimation" margin of 2 to 3 dB or more. That is, an open loop downlink power management system may operate at, say, a 6 dB back-off a large fraction of the time in order to ensure that it does not ever exceed the specified 3 dB back-off. A closed-loop system uses measured observations to estimate how close the downlink power is to the specified operating point, and adapts network loading taking this into account. Maintaining downlink power allocations as close as possible to the specified operating point, without exceeding it, is one of the most important resource management issues for the DAMA system.

3.3.2 *Link quality estimation*

Note that link by link adaptive Bit Error Rate (BER) control is related to, but different from, downlink power management, and may work at cross purposes. Downlink power management is a "macro" issue for the network as a whole. Link adaptive BER control is a "micro" issue for each {source-destination} user pair. The DAMA network manager must allocate an uplink EIRP for each user circuit. Simple systems may always allocate the same transmit EIRP, regardless of the service involved, or the specific end-to-end nominal link budgets. Such systems either waste significant downlink power for many connections, or fail to meet link quality and/or availability specifications on others. Somewhat more sophisticated DAMA systems will allocate uplink EIRP for each connection based on an "open loop" link budget for the {source-destination} pair and service definition. The best solution is to allocate uplink EIRP based on a closed-loop feedback control system that compensates for time-varying parameters, especially rain fading. The DAMA manager then has the best estimate of the actual downlink power consumed by that service, and can more closely manage aggregate downlink power to the specified operating limit. An adaptive link BER monitor corrects for errors in link quality. Without it, link quality may degrade below service specifications. With adaptive link control the transmit EIRP can be increased to offset uplink or downlink fading. While power adjustments to compensate for uplink fading do not increase downlink transponder power consumption, adjustments to compensate for downlink fading do. So, adaptive BER control must be coordinated with aggregate downlink power management in order to avoid positive-feedback instability. But, if properly applied, adaptive BER control can free up several dB of system power.

3.3.3 *Voice Activation*

Voice activation is a technique that can "stretch" the amount of apparent downlink power available from a transponder. It takes advantage of a well-known aspect of voice telephone circuits, which is that both parties seldom speak at the same time. A satellite network can take advantage of this if terminals "suppress" the uplink EIRP associated with a voice carrier when there is no transmit voice activity on that carrier. This requires careful coordination between the vocoder, which can make the speech present/absent decision, and the modem, which invokes the carrier present decision. Results from Time Assigned Speech Interpolation (TASI) or Digital Speech Interpolation (DSI) telephony systems show that on the average, each end of a voice conversation is active less than about 50% of the time. If a large network uses voice activation then the DAMA controller could allocate almost twice the downlink power it would without voice-activation. (This excludes circuits used for voice-band fax or modem data).

4. Application Example

The example folds in each of the technical issues identified in the preceding sections. We start with a simple, unsophisticated system and build to a powerful DAMA resource manager. The increase in system capacity is dramatic.

4.1 THAICOM 2 & Ground Segment Technical Data

We used the following basic satellite technical data for our analysis:

- K_u band transponders.
- Uplink 14.316 - 14.495 GHz.
- Downlink 12.568 - 12.747 GHz.
- Transponder BW - 54 MHz.
- Max downlink EIRP: 53 dBW
- Max TWT power: 47 W
- Max uplink G/T = 10 dB/°K
- Nominal transponder Saturation Flux Density = -82 dBW/m^2
- Input/Output Backoff: 6 / 3 dB

We used the following network and traffic data:

- 1.2 m antenna for each user terminal
- 2 W linear SSPA for each user terminal
- Noise Temperature - 120°K for each user terminal
- 1 ppm local terminal references
- BPSK or OQPSK modulation with 1.4x carrier spacing
- Mix of 10 cities in Thailand with Crane rain fade model for regions G and H
- 99.8% availability at 10^{-5} BER (no noticeable voice quality degradation)
- Uplink rain losses: Region G: 3.5 dB, Region H: 8.3 dB
- Downlink rain losses: Region G: 2.5 dB, Region H: 6 dB
- Full duplex voice connections.

4.2 Transponder loading analyses

The following cases show the impacts of each technical feature on total system loading. For all cases we ignore the DAMA system orderwire, since this accounts for only a small fraction of total resource usage. It is important to note that the exact sequence that we apply each technology is somewhat arbitrary. So, it is not easy to allocate a particular step increase in system capacity to a particular technology. We are not trying to imply that one particular technology accounts for X% increase in the total system. But, we are showing that the combination of different technologies can result in either bandlimiting, or power limiting. So, a good DAMA system can mitigate either situation.

4.2.1 Case 1 - Nominal DAMA System

This system uses the following "typical" attributes:

- 32 kbps ADPCM G.727 voice
- BPSK modulation
- R=$^1/_2$, K=7 FEC
- No uplink frequency pre-correction
- 22.5 kHz frequency resolution
- Open loop power management and link quality

This system supports 171 services. It is band limited. A significant fraction of the bandwidth is consumed due to the coarse tuning resolution and frequency guard bands. Each full duplex circuit pair requires 157.5 kHz of bandwidth (7 units of the 22.5 kHz resolution increment). Figure 3 - Bandwidth Consumption shows how the total bandwidth is used. "Irreducible" bandwidth is the actual amount used by the services. Significant bandwidth is consumed by guard bands due to reference accuracy and by the tuning resolution.

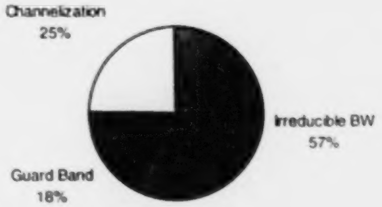


Figure 3 - Bandwidth Consumption

4.2.2 Case 2 - Finer tuning resolution

This system is the same as Case 1, but we reduce the tuning resolution down to 2.5 kHz. This increases the number of full duplex circuits up to 220 by reducing the percentage needed for channelization down to 3%. The system is still bandwidth limited. There is sufficient downlink power to support 700 circuits.

4.2.3 Case 3 - Replace 32 kbps with 16 kbps Vocoding

If we use 16 kbps G.728 voice compression we reduce the bandwidth required for each full duplex pair significantly. This improvement increases the number of traffic circuits to 348. The system is still bandwidth limited. Figure 4 - Bandwidth Consumption shows that a large amount of bandwidth is still used in guard bands, but with 2.5 kHz tuning resolution the channelization overhead is only 5%.

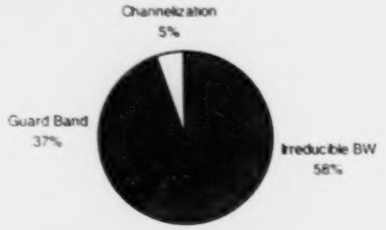


Figure 4 - Bandwidth Consumption

4.2.4 Case 4 - Use OQPSK modulation

Now we consider improvement due to OQPSK modulation. This halves the actual amount of bandwidth needed for each traffic circuit compared to BPSK. But, the overhead due to frequency guard bands becomes more pronounced, limiting the total number of full duplex circuits to 514. Channelization is held at 2.5 kHz.

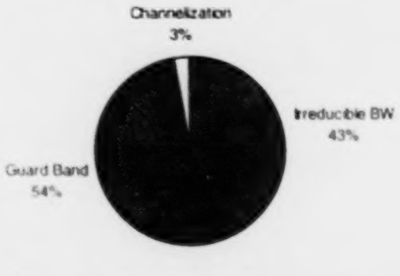


Figure 5 - Bandwidth Consumption

4.2.5 Case 5 - Add uplink frequency pre-correction

From Figure 5 - Bandwidth Consumption, we see that guard bands account for a large fraction of the bandwidth, in a system that is still bandwidth limited. An uplink frequency pre-correction algorithm compensates for the uncertainty in the 1 ppm reference at each subscriber terminal. This allows us to reduce the frequency guard band from 14 kHz per carrier down to 500 Hz per carrier. It reduces the bandwidth allocated per full duplex pair from 105 kHz down to 55 kHz, still using 2.5 kHz channelization. Correspondingly, the total number of full duplex circuits per transponder jumps to 699. Guard bands are now a small fraction of total bandwidth, and the channelization becomes more of a factor. And, for the first time, the system becomes power limited. So, reducing the channelization would not help at this point.

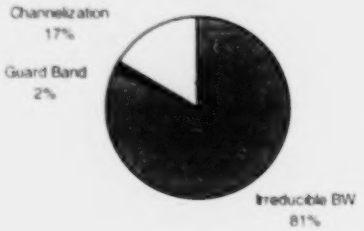


Figure 6 - Bandwidth with Pre-correction

4.2.6 Case 6 - Add Voice activation

Adding voice activation reduces the average power used by each traffic circuit by 50%. Since we are already using a relatively low code rate (R=$^1/_2$), this is a good way to improve capacity. It increases the number of active full duplex circuits to 981. Plus, the system becomes bandlimited again.

4.2.7 Case 7 - Reduce tuning resolution to 500 Hz

Now, improving the channelization to 500 Hz increases the number of links to 1148. The result is 95% of the available bandwidth is actually allocated to traffic circuits. Bandwidth and power are now closely balanced.

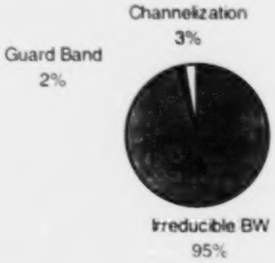


Figure 7 - 500 Hz tuning resolution

4.2.8 Case 8 - Adaptive link and power control, high rate FEC

The system in Case 7 requires a significant amount of link margin at K_u band to achieve the specified 99.8% availability. In clear sky conditions, average BER is orders of magnitude better than the specified 10^{-5} value. Users would be better served by applying that excess downlink power to serving more traffic, instead. An adaptive link quality and power control algorithm backs-off each uplink (and therefore the transponder downlink) to the amount needed to obtain the specified BER. In this case, for a ten site network in Thailand, we can free over 5 dB of transponder downlink power. This does not immediately increase the number of supported circuits, because the system in Case 7 was still bandlimited. But, now we can increase the convolutional coding rate. A higher FEC rate lets us sacrifice E_b/N_o performance to reduce the bandwidth required per circuit. For a bandlimited system, it's an effective trade-off. Figure 8 - Voice Circuits vs. FEC Rate, shows the gain in number of circuits as the FEC rate is increased. At Rate $^7/_8$ the number of circuits per transponder has increased to 2000. This is over an order of magnitude greater than in Case 1.

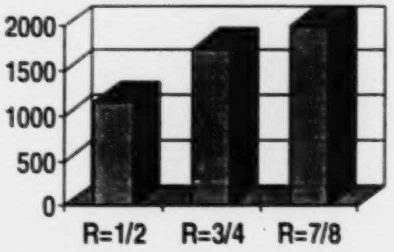


Figure 8 - Voice Circuits vs. FEC Rate

4.2.9 Case 9 - 8 kbps G.729 vocoder

The ITU recently defined a new 8 kbps vocoder, providing voice quality equivalent to the 16 kbps G.728 standard. Future DAMA networks can incorporate this voice compression rate and improve traffic capacity even further. Adding G.729 to the technology mix in Case 8 increases the number of simultaneous voice circuits to 3600 - more than a factor of twenty greater than in Case 1. Besides the added computational complexity due to voice compression, the system must be able to tolerate the increased impact of close-in phase noise for the lower information rate.

5. Summary

Our paper describes a set of well known satellite resource management and signal processing techniques that are appropriate for advanced thin-route mesh DAMA networks. We have demonstrated that careful DAMA resource management can support twenty times the subscriber base of what otherwise might be considered a nominal bandwidth on demand control system. The increase in capacity dramatically lowers the recurring cost of satellite thin route telephony networks. And, when transponders are in short supply, such advanced technologies may be the only way to serve the traffic demand.

Smart-Networking—
Efficient Technology-Transparent Connectivity

John Puetz & Steve Hart
ViaSat, Inc.
Carlsbad, California USA

Abstract - VSAT technology has evolved over recent years to adapt to the changing connectivity requirements of the user community. However, few VSAT-DAMA implementations provide data-communication facilities that provide both transparency to the end-user and efficient communication services. Even fewer provide a truly integrated approach to applications interfaces that optimizes network sharing with the added benefits of efficient access and reduced implementation costs.

Introduction

Smart-Networking™ refers to the ability of a communications network to provide just the right amount of service to each user of the network, with the highest quality service level. The network carefully balances unused capacity and service setup time, and makes efficient use of the communications media to which it has access. The smart network allocates just enough capacity to serve an immediate need, rather than forcing all users to use the same class of service, or draw from a few pre-defined service classes. Most importantly, the network does this with no direct involvement on the part of network users.

In the terrestrial networking world, there has been steady progress towards smarter networks. Integration of LANs and WANs can be accomplished very smoothly, and the use of bandwidth-on-demand (BOD) routers and protocols like Frame Relay and ATM have provided opportunities for efficient sharing of communications trunks.

In the satellite communications world there has also been progress towards smarter networks. VSAT systems have been around for over 10 years, providing transparent data networking using various packet-based protocols such as integrated X.25. These VSAT systems are efficient at transporting small volume interactive (inquiry/response) data applications like automated teller machines, point-of-sale and inventory applications with responsive turn-around and reasonably good efficiencies. However, the inherent limitations of the satellite access protocols (aloha and slotted-aloha) and the underlying packet protocols yield significant satellite channel and data through-put inefficiencies when they are used to transport the newer protocols such as TCP/IP, Frame Relay and HTTP.

Within the past several years, smart networking for voice communications over satellite has been very successfully provided by Demand Assigned Multiple Access (DAMA) systems. These DAMA systems have proven effective in sharing satellite resources, with relatively short service setup times and very good transparency to the end-user. Calls are automatically routed within the system using virtual circuits between end-nodes. This dynamic routing is based on in-band addressing (e.g., phone numbers), typically provided by DTMF dialing. Only the bandwidth and power required to provide the service is allocated from the overall system resource "pool". Once the call has been completed, the resources are returned to the system pool. Thus the DAMA system works analogously to the switched public telephone system.

However, very few DAMA systems have applied the real power of dynamic resource allocation and intelligent networking beyond telephony services. This paper addresses the application of DAMA to data communications, cites the significant advantages of tightly integrating the application interface and presents a system which implements *smart-networking*.

Data Services & Protocols

All data communications can be classified into three categories: dedicated (non-switching) circuit, switched circuit and packet based (frame and cell relay are variants of packet systems). Dedicated circuits are full time communication links that are always established, even if no traffic is present. A leased line is a PSTN equivalent.

A switched circuit is a communications path that is established between two points (usually) for a finite period of time (e.g., 1 to 60 minutes). There is an established protocol for specifying who participates in the service (address of each end) and how the circuit is established and removed. While the circuit is in use, the full bandwidth of the communications path is available for use by both parties (assuming a bi-directional, full duplex link) even if no traffic is present. When the transmission facility is no longer needed it becomes available for other traffic.

In packet-based communications the transmission is segmented into small groups, or packets, of data that are completely self-contained, that is they have an address (source and destination) and a duration (measured in seconds or fractions of a second). The data packets typically require the full bandwidth of the transmission channel, but only for the duration of the packet, after which the transmission channel is available for reuse.

Table 1 provides a summary of widely used and emerging communications services, their associated addressing protocols and the category type. The SNA and SDLC protocols and their close cousins (Bisync, Burroughs Poll/ Select, etc.) support the main-frame computing infrastructure that dominated when VSAT technology emerged in the '80s. These protocols are no longer playing a significant role in new system deployments. Their popularity is diminishing and directly track the main-frame computers' life-cycle. On the other hand, X.25 has found tremendous acceptance and widespread use primarily because of its ISO adoption in wide area networks (WAN) and in public switched digital networks (PSDN). X.25 connectivity is provided at lower transmission rates, typically 4.8 to 38.4 kbps, with considerable protocol processing necessary within satellite terminals to fake-out or "spoof" the various aspects that are inherent (packet acknowledgments, short time-out periods, etc.) in the protocol. X.25 is well entrenched in the Pacific Rim as the datacomm interface of choice.

Table 1: Communication Services & Protocols

Category	Service Types	Addressing Protocols
Dedicated	Leased terrestrial line or SCPC satellite circuit	Permanent (not applicable)
Switched Circuit	ISDN (BRI/PRI) Video conferencing Analog telephone Digital voice	D-Channel RS-366 DTMF, Pulse, R2, SS5 G.704, R2, SS5, SS7
Packet	SNA, SDLC, HDLC X.25 Frame Relay TCP/IP HTTP	Native LAP-B DLCI IP IP

In other areas of the world, such as Europe and North America, X.25 is being augmented and replaced by ISDN and frame relay respectively. Integrated Services Digital Network (ISDN) has been well received in Europe and in the past several years has become widely available in the United States. While these circuits are available in multiples of 64 kbps, there is particular interest in the basic rate interface (BRI) operating at 192 kbps and primary rate interface (PRI) operating at T1/E1 rates. Of significant interest is the growing popularity of conducting desktop videoconferencing over ISDN circuits. Recent price reductions are causing a huge growth in market penetration and widespread use. This has sparked considerable interest in establishing BRI capability into areas without significant telecommunications infrastructure--an ideal application for satellite networking.

In the past several years, frame relay (FR) has emerged as the replacement for X.25. FR, while similar to X.25, provides a number of advantages, which include: 1) increased system performance (higher operating rates and less throughput delay) with reduced network complexity (much of the protocol processing is removed from the transport network and pushed to the endpoint devices) and 2) reduced internetworking costs (reuse of a physical connection by multiple logical connections using statistical multiplexing). In frame relay, data is transferred in variable length "frames" complete with addressing information within the frame header. Frame relay provides two types of "circuits" (paths over which frames are transported): permanent virtual circuits (PVC's) and switched virtual circuits (SVC's). PVCs assign the end-points of a link which are permanently established, but transport resources are used only when requested. SVCs provide a means of assigning circuits on a switched virtual basis, thereby reducing the management overhead of the data link connection identifiers (DLCI.)

Internetwork Protocol (IP) has established itself as a backbone for LAN and WAN communications. With the popularity of the Internet skyrocketing and the proliferation of PC workstations, the integration of internetworking protocols into operating systems is emerging with OS-2, Windows NT and Windows 95 as examples. New levels of performance are achieved for the ever increasing demands now being placed on LANs, file servers and pooled network resources.

Smart-Networking and the WWW

Consider for example a Web-surfer (a user on a personal computer running a World-Wide-Web (WWW) browser). A Web-surfer who wants to look at a piece of information or a graphic just clicks a mouse and, thanks to the magic of the HyperText Transfer Protocol (HTTP) with an integrated network, connections are established, packets are routed, transmitted, and acknowledged with the desired information displayed to the surfer. With this in mind, consider the two key attributes of a smart satellite network.

1) *Transparent Connectivity*: Networking is now built-in to the most popular applications running on computers. The users of computer equipment connected to a network don't need to manually set up network connections for each location they access. The software and hardware has the capability to do it all for the user, including initializing the LAN card, searching for the servers, dialing the phone, and the like. The WWW user may not even know that the information started out at a point half-way around the world, let alone what intermediate wires, switches, routers and protocols were involved in getting the data. An effective satellite network must provide this same level of transparency.

2) *Efficiency:* Satellite power and bandwidth can be expensive, if not used efficiently. The early VSAT networks were able to provide significant cost savings by using shared channels (versus nailed-up circuits). But for higher-bandwidth network needs, the inefficiency of a random access channel (less than 37% throughput to capacity ratio) can not be tolerated. DAMA provides very efficient sharing of satellite resources, but only if it is providing access that matches the user's needs. For the WWW surfer this likely involves more data received than transmitted, and only while actively surfing (the user doesn't need any capacity while using a local application on the same machine). For the satellite network to be truly cost-effective, it must provide this type of resource efficiency which can only happen if the satellite network is "smart" about the user requirements.

With these attributes in mind, let's turn our attention towards network design for smart-networking.

Satellite Network Design

In designing a satellite system the underlying characteristics of the service regarding how the service will be implemented for maximum system throughput, minimal set-up delays and overall network efficiencies are very important.

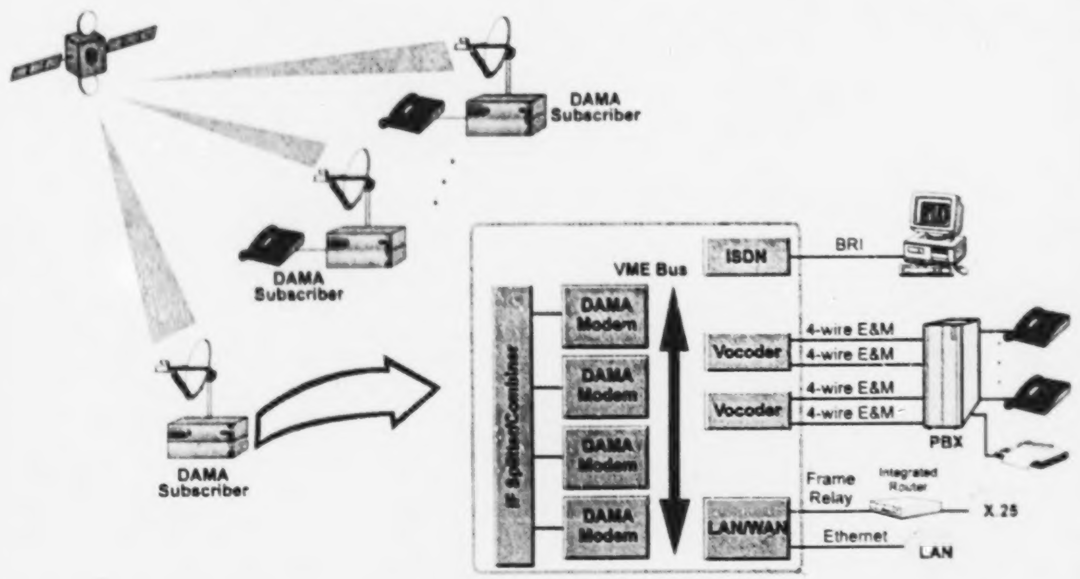
To meet the growing trend towards increased performance and efficiencies, coupled with higher throughput requirements, a successful satellite network must have a truly integrated approach in design and implementation.

Foremost, access to the satellite channel must be efficient. Contention-based data transport (used in traditional VSAT systems) cannot efficiently support the constancy of circuit communications, nor the higher traffic volumes of frame relay or IP packets. By implementing a mixture of contention-based TDMA access for control channels with DAMA service transport channels, much greater throughput is possible and resource management efficiencies are significantly increased. In implementing the transport backbone, considerable care is required to minimize the resources required for overhead functions (framing, control messaging, timing, etc.) versus those used for transporting services.

Secondly, data interfaces and protocol implementations must be an integral part of the satellite terminal and closely tied to transport channels. As mentioned earlier, some equipment vendors attempt to provide IP services encapsulated within their X.25 transport. While connectivity is possible, it comes with severe penalties in low throughput (because of high overhead) and significant throughput delays. Tighter integration permits implementation of the protocol stacks directly at the interface, and interfacing to the transport layer(s) based on parameters associated with the service (i.e., type of service, destination, priority, data rate). This affords a secondary, but very significant advantage in that transport bandwidth can be dynamically expanded (or reduced) based on the volume of traffic at a given port, or, dynamically re-allocated across the network to more evenly distribute performance.

A *Smart-Networking* Solution

The ViaSat demand-based smart-networking solution, **db-Net™**, offers an unprecedented combination of flexibility and efficiency for


DAMA Subscriber
DAMA Subscriber
DAMA Subscriber
VME Bus
IF Splitter/Combiner
DAMA Modem
DAMA Modem
DAMA Modem
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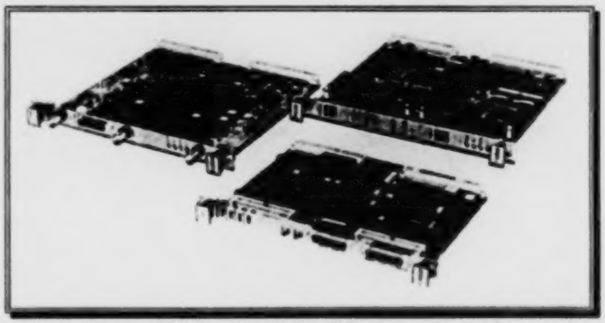
ISDN
BRI
Vocoder
Vocoder
4-wire E&M
4-wire E&M
4-wire E&M
4-wire E&M
PBX
Frame Relay
Integrated Router
X.25
LAN/WAN
Ethernet
LAN

Smart-Networking System Terminals

network data communications. This flexibility is achieved by the use of an open architecture chassis, powerful low-level communications tools, fully integrated data network services, and extensions for additional network services.



VME based SCPC DAMA Modem, Vocoder and Data Communications Controller

The open-architecture chassis allows a user to put together a system which directly addresses the networking needs of a site. This includes multiple types of satellite communications links (SCPC, MCPC, TDMA or control), as well as multiple types of network interfaces. A VMEbus backplane acts a real-time switch providing virtual connections between user interface ports and communications ports (modems). Each communication link or network interface can be just another card in the chassis. The built-in terminal control software puts the cards together into a seamless smart-network solution. The local terminal control software can then interact with the centralized Network Control System to provide automatic network-wide resource allocation.

Figure 1 shows the hierarchy of tools which make up the complete data networking capabilities of the system. Three different, but tightly integrated, data transport mechanisms are provided in the system:

1) *Message Transfer*: Low rate (<64 kbps per network) transfers, without the need of additional SCPC modems. These transfers are handled by the control modem, using the

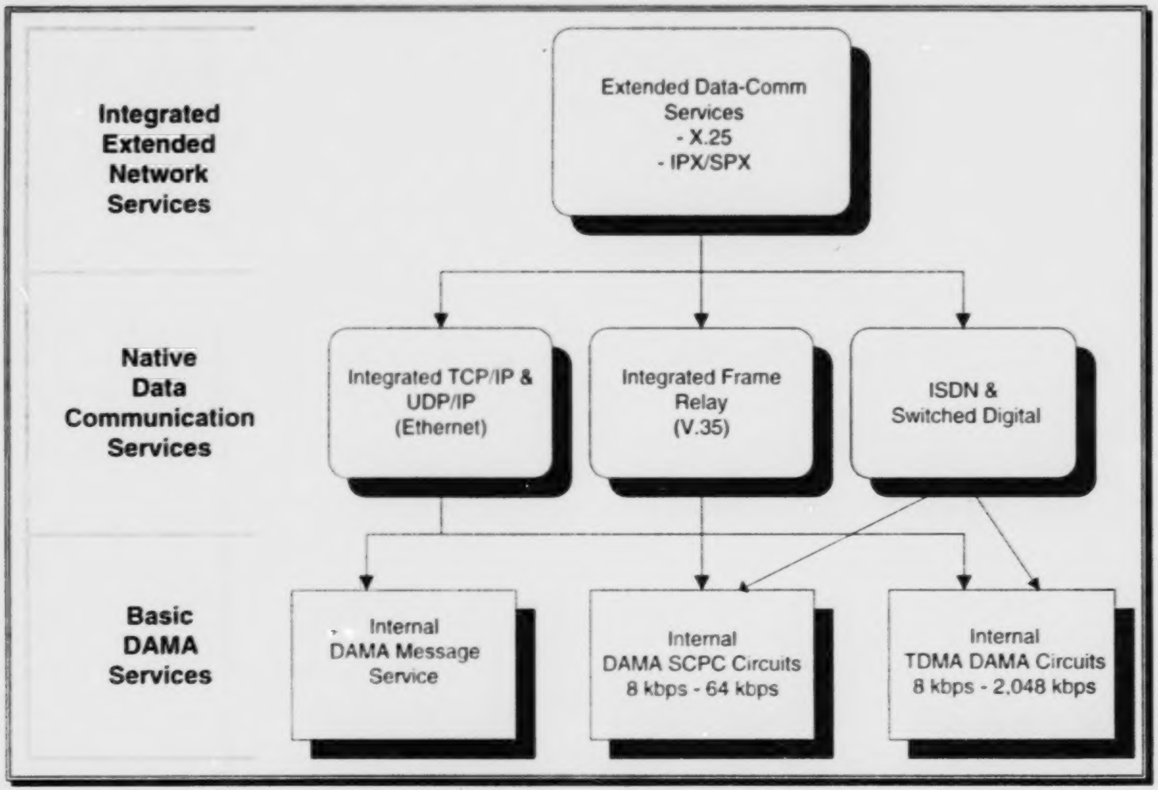

Integrated Extended Network Services
Extended Data-Comm Services
- X.25
- IPX/SPX
Native Data Communication Services
Integrated TCP/IP & UDP/IP (Ethernet)
Integrated Frame Relay (V.35)
ISDN & Switched Digital
Basic DAMA Services
Internal DAMA Message Service
Internal DAMA SCPC Circuits 8 kbps - 64 kbps
Internal TDMA DAMA Circuits 8 kbps - 2,048 kbps

Figure 1: Data Communication Tools Hierarchy

special inbound and outbound multiple access data channels. Capacity setup time is required, and the Network Controller assures the availability of the data recipient. Channel capacity is allocated based on the message size, with the bandwidth returned to the system immediately upon delivery of the message. This service is very efficient for non real-time applications such as e-mail and background file transfer.

2) Low Speed DAMA Service: This service is set up on demand, to provide a full-duplex or simplex circuit. The service is provided by an internal SCPC DAMA modem. The modem can take its data from any bus data card (Frame Relay, ISDN, Ethernet, serial interface card or vocoder). Circuits operate from 4.8 kbps to 64 kbps.

3) High Speed DAMA Service: This service is very similar to the previous, with higher capacity channels (64 kbps to 8 Mbps). This service can be provided by either SCPC modems or TDMA modems.

To effectively (and efficiently) use these services for data communications, the system offers access to three internal (Native-mode) data communications services: ISDN and switched digital communications, Internetwork Protocol (IP) routing, and Frame Relay (FR).

Switched Digital and ISDN Communications

Switched digital services are provided either by a direct connection between an external serial communications device and the modem or an ISDN basic rate interface (BRI) module. The circuit can be set up automatically (using V.25bis, Hayes AT dialing protocol or ISDN D channel), or manually via the control interface. This communications mode can make use of either the internal SCPC DAMA modems or TDMA DAMA modem but it is not appropriate for the message service.

IP Routing

The terminal provides a full IP protocol stack, and IP interface, which is used for internal communications, as well as routing of IP packets. The Ethernet port is used to provide connectivity either directly to a LAN, or to an external IP router. The system provides RIP routing. IP routing can make use of the message service, one or more SCPC DAMA circuits, or the higher speed TDMA circuits. The selection of routing preferences can be automatic (via rule-based routing) or controlled by configuration parameters (e.g. certain addresses use specific communications mechanisms). With fully automatic routing, the Ethernet interface selects to send a small number of protocol data units (PDU's) via the message service. As the queue length grows, it adds one or more SCPC DAMA circuits (depending on the availability and allocation of DAMA modems) or a multirate TDMA circuit (if available).

Frame Relay

The frame relay (FR) interface provides the perfect interface for satellite DAMA services. It allows for flexible routing (as described above for the IP interface), and demand-based bandwidth allocation, with significant advantages over strictly packet-based routing (such as IP or X.25). FR provides for relatively low delay frame transfers, plus provides support for flow control (forwards and backwards), which is needed to allow efficient bandwidth allocation. FR is fast becoming the WAN interface of choice for low to medium data rate applications, with a large number of Frame Relay Access Devices (FRADs) available to provide any type of popular data interface.

Efficient allocation of resources is managed via careful setting of two frame relay parameters per virtual circuit: the Committed Information Rate and Excess Burst Size setting are tightly coupled to the DAMA system to efficiently use the costly satellite resources. Committed Information Rate can be set as low as 0 bps for a given virtual circuit, allowing the DAMA system to tear down any allocated resources when the interface is not being used. Then, as traffic presents itself, the DAMA system can allocate more bandwidth, up to the Excess Burst Size setting.

Resource Optimization

With a powerful integrated network management and control, combined with the wide variety of connectivity options, the terminal's service interfaces can be configured to exactly match the needs of a specific site, providing seamless connectivity with optimized use of resources. The following four criteria are used in optimizing system operation:

Preferred Link Type - The link type (message, SCPC DAMA circuit or TDMA DAMA) can be selected automatically or manually. Selectivity can be made for an entire interface (e.g. an Ethernet or serial port) or on an individual address basis (IP node address, X.25 address, frame relay DLCI, etc.). The decision is made internal to the DAMA chassis, and the routing is done across the backplane.

Preferred Routing - As with link type, the routing can be done in any combination of automatic and manual control. Based on required connectivity, destination terminal type (SCPC, TDMA or both), link margins, and dynamic routing tables, the data may be routed directly to a destination terminal, or sent via a selected hub station. Update of dynamic routing protocols is provided.

Timing/Buffer Thresholds - For automatic setup and teardown of circuits (TDMA or SCPC), the system uses timer values, coupled with buffer length parameters to determine when to use DAMA message service, when to perform initial circuit setup, when to add more resources, when to change link type, and when to tear down links. The timer thresholds can all be tuned via the integrated network control/management system to provide desired latency vs. efficiency.

Priorities - All services are allocated on a priority basis, with priorities set on either a terminal wide basis, an interface basis or on individual addresses. Priority is used both to determine the order of service, as well as to perform optional preemption. Any link can be designated as preemptable or non-preemptable.

Integrated vs. Non-Integrated Solutions

The integrated "Smart-Network" for satellite provides direct connections between the network protocols and the satellite transport mechanisms. So the external user network interface connection may be IP over Ethernet or Frame Relay over synchronous serial. Internally the system can allocate bandwidth and connectivity based directly on the communication requirements of the moment, as dictated by the packets or frames arriving at the network interface.

This is in contrast to a traditional VSAT or SCPC DAMA system, which presents only a X.25 or transparent serial port to the user. To get access to the needed services, such systems can be augmented with an external router. But a non-integrated router is not designed to make optimal use of demand-assigned channels. Even a sophisticated bandwidth-on-demand router can only deal with setup and tear-down of fixed data rate circuits which is a rough approximation of the real user demands. Thus, the four resource optimization criteria noted in the previous section cannot be met.

Only by having the user interface implemented within the DAMA equipment can optimization occur. Table 2 contrasts the *Smart-Networking* solution with traditional SCPC DAMA and VSAT systems.

Note that traditional VSAT systems (TDMA/TDM) provide only a limited amount of intelligent networking as it pertains to TCP/IP and X.25. As previously mentioned, it encapsulates newer protocols within X.25 thereby providing inefficient and minimum service. Traditional SCPC DAMA, when coupled with an intelligent remote access router, provides considerably more capability than VSAT. However, when compared to an integrated approach where resource optimization and intelligent routing capabilities are implemented, it fails to deliver in performance and costs substantially more to implement.

Conclusion

Frame-Relay, Asynchronous Transfer Mode (ATM), ISDN, TCP/IP, Appletalk, Banyon Vines, are but a few of the internetworking protocol environments available today, each with their own unique characteristics. These characteristics can be best met by tightly integrating user service interfaces with intelligent routing of data either using virtual circuits or packet based transmission under DAMA control. This is *Smart-Networking*.

Users of all types of networking systems demand a high level of service quality. This is often measured in quick connection times, high throughput, low-delay and ease of use. Additionally, users do not care how the service is provided—only that it's reliable and transparent. All of these requirements can be met by *Smart-Networking*.

Furthermore, to be competitive, network service providers must operate systems that provide the best efficiency and highest level of network availability. These goals are achieved with *Smart-Networking* by dynamically routing traffic over the transport media best suited for the service. This minimizes overall network resource waste and ensures the highest number of possible services are offered. Because the interfaces are integrated within the terminal equipment, service providers and users benefit with lower equipment costs.

To meet the changing and diverse data needs in today's broader global networking environment, the emerging economies' service providers are looking towards satellite communications to provide wireless connections with the same level and types of services being offered by terrestrial systems. *Smart-Networking* does just that and it can be applied to a host of data communications: TCP/IP, frame relay, HTTP, ISDN and X.25.

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Table 2 - Evaluation Matrix

Evaluation Criteria	DAMA with Integrated Interface (*Smart-Networking*)	DAMA with External BOD Router	Traditional VSAT
Multiple bandwidth transmission paths	√	√ (limited)	—
Transmission media routing based on in-band addressing	√	√ (limited)	—
Resource optimization (see text)	√	—	—
Node-to-node connections	√	√	—
Traffic routed through central location	√	√	√
Implementation of FR, ISDN, & HTTP	Integrated	Within external router	—
FR, ISDN, & HTTP throughput efficiency	High	Moderate	—
Frame Relay, ISDN & HTTP capacity	Low ⇨ High	Low ⇨ High	—
Implementation of TCP/IP (LAN)	Integrated	Within external router	Integrated
TCP/IP throughput efficiency	High	Moderate	Low
TCP/IP capacity	Low ⇨ High	Low ⇨ High	Low
Service quality (bandwidth, throughput, short setup time, routing efficiency, etc.)	High	Moderate	Low
Cost	Low (no additional equipment)	Moderate (External router needed)	Low (TCP/IP only)

RECONCEPTUALIZING TELECOMMUNICATION DELIVERY SYSTEMS FOR RURAL POPULATIONS

Richard P. Dowling
General Communication, Inc. (GCI)
Anchorage, Alaska, USA

Abstract

Responding to an urgent need to replace an outdated, inadequate and inefficient telecommunication system in Alaska's rural areas, a new approach was adopted by the design team. It was necessary to break from past methods in order to satisfy market needs in an environment where sparse population spread over a large area has resulted previously in cost of service levels requiring large amounts of external subsidy. No such subsidy payments are available in the current environment. This paper presents the background and problems faced and documents the process that the design team used to successfully achieve multiple, often conflicting, objectives.

Introduction

Existing telecommunication systems in Alaska's sparsely populated Bush, although state-of-the-art when installed in the mid-1970s, are now wholly inadequate to support urgent and growing needs for modern commerce and societal integration. Telecommunication service in Alaska is currently delivered by thin-route satellite networks comprising more than 150 small earth stations, 18 medium-sized earth stations in regional centers, and three large gateways. This paper describes the World Access for Rural People (WARP) mission to develop a replacement for the existing system and sponsored by General Communication, Inc. (GCI). Criteria for the new system mandated: (a) use of conventional C-Band domestic satellite service, (b) levels of service (variety, quality and reliability) to rural Alaska consistent with those in urban areas, (c) costs held to the lowest practical level, and (d) performance in a physical environment that presents special problems of wide temperature ranges, insects and clouds of glacial silt in summer, heavy snowfall in winter, plus the extreme isolation of most sites.

The design team took an holistic approach in considering the scope, service requirements, difficulties, and constraints in reconceptualizing service delivery. During an 18-month internally-funded R&D project, the team established breakthrough bilateral company-supplier partnerships which enabled the development of hardware and software system elements, support systems, and operations methods. This has produced an integrated and highly reliable environmental enclosure system, a move from the historical "construction" approach to a less expensive manufacturing strategy, the employment of Demand Assigned Multiple Access (DAMA) protocols to reduce satellite operating costs, and operations systems that centralize network expertise and surveillance while decentralizing logistics.

The result is a highly integrated system of small C-band earth stations capable of rapid and economical deployment which meet today's communication requirements and provide a designed-in growth path for future needs. The network of stations can be managed and sustained by a cross-functional logistics, operations, maintenance, and provisioning team aided by state-of-the art support systems. Thus, for the first time, rural Alaska can have a reliable and fully-featured telecommunication system meeting modern communication needs, capable of supporting telemedicine, distance learning and administrative computer systems. These enabling technologies make possible the creation of an information economy to supplement the subsistence-based lifestyle of most rural residents.

The system that has been developed for rural Alaska will be highly applicable to less-developed areas throughout the world.

The Current Status in Alaska

Alaska comprises 586,400 square miles with terrain ranging from temperate rain forest to arctic tundra. With over one percent of world's land area, Alaska would rank as the world's twentieth largest country, if it were not part of the United States. In the list of countries larger than Alaska, only Greenland has a smaller population density. Seventy percent of Alaska's population lives in and near its three largest communities, Anchorage, Fairbanks and Juneau. The remainder of the population lives in 18 regional centers of up to a few thousand people each and in over 150 Bush villages, ranging from 25 to less than a thousand people; these are scattered throughout the state on its rivers and coastlines. (Figure 1 shows Alaska's size compared to the original 48 states of the U.S.) Except for Anchorage and Fairbanks, few of Alaska's communities are on its limited road system. Most Alaskans came to the state from other places in the U.S., while the remaining population is made up of six indigenous groups and seven subgroups, speaking six languages. Lifestyles and per-capita incomes range from those found in other U.S. cities to subsistence levels in the Bush. The state's economic activity is derived largely from resource extraction, fishing, service, and tourism. In the Bush there is little economic activity other than from fishing or from government employment at the state and national level.

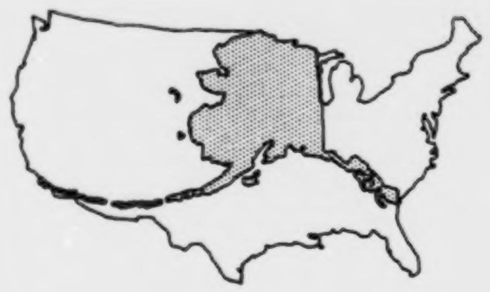


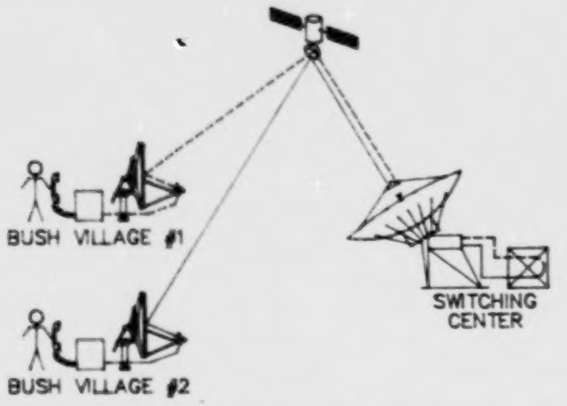
FIGURE 1

In the late 1960s, 10 years after statehood, most Alaskans had access to limited telecommunication services. Service was provided on an as-available basis by the Alaska Communication System (ACS), operated by the United States military. The ACS employed tropospheric scatter and analog microwave technology to carry its traffic and other than military installations served only the largest cities. Rural Alaska had almost no commercial telecommunication service. Health and safety communication was implemented mostly by high frequency radio, notoriously unreliable in Alaska's northern latitudes. Military operation of the system ended in 1969 when the RCA Corporation acquired the ACS and began a program of expansion and modernization in the urban areas. The Bush, however, received only limited attention until 1975. That year the State of Alaska and RCA built small earth stations to serve 120 rural locations. Representing new technology at the time, the Bush earth stations consisted of 4.5-meter C-Band antennas and were equipped with analog Single Channel Per Carrier (SCPC) voice channels.

Initially, two circuits were installed at each village; one for the village health aide and the other to a single public telephone. These small earth stations revolutionized telecommunication in Alaska by giving rural communities long-distance service connecting them to all of Alaska and the rest of the world. During the following two years the small earth stations were equipped to receive television and to broadcast it locally through low-power transmitters, giving each rural community at least one TV channel for commercial and public television programming. For the first time, anywhere on earth, small earth stations were employed for operational commercial communication on a large scale basis. This bellwether demonstration of the feasibility of such small stations for communication and broadcast services led to the plethora of similar ones on a worldwide basis.

Access to long-distance telephone service stimulated the growth of local telephone exchanges at nearly all Bush locations, and almost every household in Alaska now has access to the telephone network. Consequently, it has been necessary to install additional channels in the SCPC equipment to handle the increasing volume of long-distance traffic.

Although the Bush earth stations were state-of-the art in the mid-1970s, and represented a dramatic improvement in communication service, they cannot handle today's data requirements nor do they meet the voice quality standards of modern networks. Currently only voice and limited, low-speed data service is available to rural residents. The existing SCPC equipment uses fixed-channel assignment in which the required number of channels is dedicated from each Bush earth station to urban switching centers on a full-time basis. This method of operation requires that calls pass through the satellite twice whenever they go between Bush locations. (Figure 2) This "double-hop" calling degrades transmission quality for speech and data. Full-time assignment of channels through the satellite, whether or not they are being used, wastes much of the expensive satellite resource and greatly increases cost of service.



FIXED ASSIGNED DOUBLE-HOP CALL
FIGURE 2

Operation and maintenance of small earth stations at remote rural sites is inefficient and costly. Historically, a qualified technician with test equipment and spare parts is dispatched by air taxi after a failure has occurred. Since little, if any, diagnostic information is available from the site, the technician must analyze the problem after arriving. Replaced equipment must then be adjusted to perform properly at that location, a procedure requiring highly-skilled personnel and much test equipment. Responding to failures instead of attempting to prevent them causes outages of unacceptable duration. A new approach is necessary to improve reliability and to reduce cost.

Although revolutionary at the time, the Bush earth stations which were based upon design constraints of 20 years ago, have remained static in their performance and are now outmoded. The needs of Alaska's Bush residents, however, have not stood still. A fresh beginning, free from the limitations of the current system, is badly needed. It is with this backdrop that GCI set out to develop a system to address the needs of rural Alaska, for the present and, for the future.

Developmental Objectives

Founded in 1979, GCI operates in the Alaska market as a full-service interexchange carrier serving all urban locations as well as many regional centers. The company's vision is to serve all identifiable communities throughout the state. To that end, the primary objective is to employ technology and operations methods which deliver service at competitive prices, without subsidy transfer payments enforced by regulation. This goal cannot be fulfilled, however, unless substantial departures from past practices are made. To move toward this goal, the company funded an internal R&D project in early 1994 to develop and refine the concepts it had been exploring in previous years.

The major objectives of the design for rural service delivery were:

- Provision of service types and quality available in urban areas
- Service reliability as near urban levels as possible
- Enhanced services available on a per-minute, non-dedicated basis
- Designed-in evolutionary paths to future services
- Affordable costs for deployment, operation, and maintenance

A key element in achieving affordable operation was to deliver a high grade of service with a minimum amount of satellite transponder capacity. The current system operates inefficiently because it employs fixed assigned channels at each location. Each village contributes only a small number of Erlangs of traffic to the network (generally less than three). This requires a group of seven to eight channels at each village to achieve the industry standard blocking probability of one percent during the busy hour. Figure 3 is a graph of trunk group size versus efficiency. Each of these small trunk groups operates at less than 40% efficiency. If all of the traffic were carried in a single trunk group of several hundred

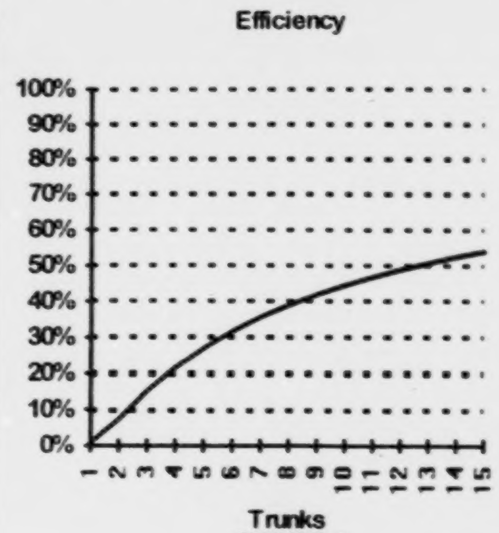
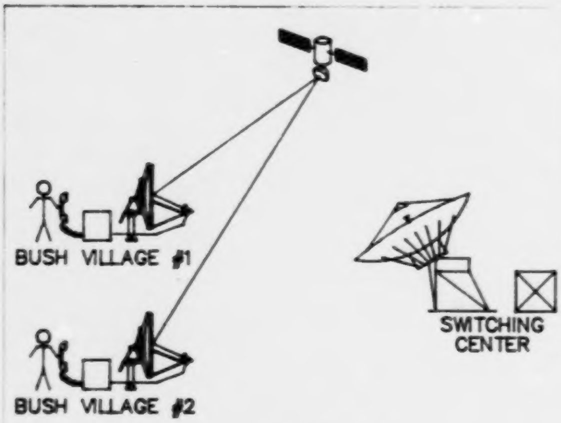


FIGURE 3

circuits, efficiencies greater than 95% would be obtained; this would then reduce satellite loading by almost two-thirds.

The concept of treating the satellite as a single trunk group lies at the heart of a technology known as Demand Assigned Multiple Access (DAMA). With this technology, a channel in the satellite is assigned for only the duration of a call, i.e., only *on demand*. When either party hangs up and terminates a call, the satellite channel is released to a pool to be used by anyone in the network. DAMA also eliminates the need for double hop transmission, since the network routes the call directly from the originating to the called location without the need to transit another earth station. Single-hop transmission further reduces the need for satellite circuits. The combination of trunking all circuits into one group and eliminating double-hop circuits reduces transponder requirement to less than one-third the previous need. (Figure 4 shows single-hop connections.)



DAMA SINGLE HOP CALL
FIGURE 4

Operational reliability requires that the equipment operating environment be maintained within an acceptable range, regardless of the natural environment. Alaska has a very wide range of conditions: summer temperatures approach 100° F (38° C) in the Interior; winter lows can dip to -70° F (-57° C). In the summer, wind and four-wheeler traffic stir up clouds of fine glacial silt; mosquitoes and other flying insects small and large are present in astonishing numbers. In winter, most parts of Alaska experience snow and ice. Coastal regions receive driving rain throughout parts of the year. Such a wide range of conditions requires a designed-for-purpose environmental enclosure for most of the electronics. Easy access to all components for maintenance is also essential. In addition, the fully-equiped enclosures must be light enough to be carried by a few people and small enough to pack into readily available commercial aircraft.

The Development Process

The design team, which drew from the company's engineering, operations, information technology, and business development groups, with full support from executive management and the board of directors, took an holistic approach toward its task. The goals contained seemingly conflicting requirements for achieving high levels of service quality and reliability while at the same time dramatically reducing capital and operating expenses from historic levels.

What evolved was a new concept for conducting the mission. Traditional methods and practices were replaced with new ways of accomplishing a task. The new ways had to take account of what could be designed, rather than accept existing equipment, methods, and practices. It became clear that, while many operational and deployment elements could be directly controlled by the company, others, system electronics in particular, could not. This would be especially true over time if the system were to be capable of accommodating future service requirements.

A new kind of relationship with suppliers of the electronics evolved. It was a partnership arrangement rather than the usual supplier-buyer relationship. Traditionally, the buyer specifies performance and features, and the supplier builds to specification and delivers the goods. Usually the buyer has no further involvement until product development is ended or the buyer wants a new feature. Then the process repeats, often involving substantial upgrades to hardware and software, as well as price increases, to accommodate the buyer's new requirements. In the WARP project, however, the parties achieved a relationship where both engaged in continuing open discussions of their business considerations and objectives.

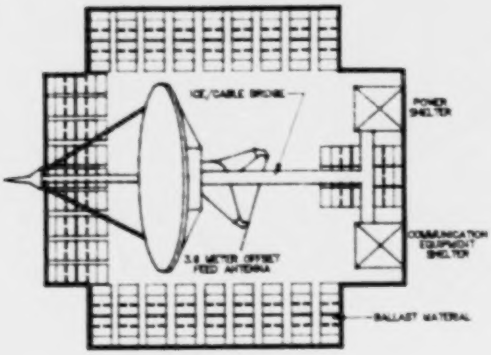
Such discussions examine questions such as: What do the users of the service provider need, now and at some point in the future? What are the goals for operational enhancements? On the other hand, where is the manufacturer trying to take its product in terms of feature and cost levels in the overall context of its product set and market segment? Which developments will the manufacturer commit to internally, instead of seeking external funding, because it sees a potential market? The manufacturer brings its capabilities in design, cost control, and marketing to the partnership. The buyer provides extensive knowledge of real networks, user requirements, and operating methods.

This is not an easy relationship, for, in the process of working together over an extended time, each party must reveal its weaknesses as well as its strengths to the other. Each party must possess confidence in itself, and in the other, in order to accept inevitable weaknesses and failings while striving to develop and capitalize upon strengths. The mission succeeded because both parties achieved this level of cooperation and teamwork.

The Product of Development

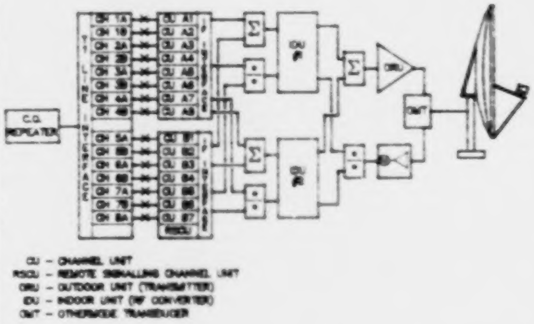
DAMA is the key enabling technology of the WARP service strategy, and forms the core of the electronics for delivering high-quality voice and conventional dial-up data. The DAMA system that was developed meets the objective of being extensible over time. The channel modules are processor based so that their personality can be changed by new software releases. This extends to most sub-functions of the channel unit including voice encoding, radio frequency coding and modulation, as well as telephony signaling and data protocols. In addition to adding new functionality, improvements in existing functions can be made by downloading new channel unit software over the satellite during periods of low traffic.

The DAMA electronics are contained on a single plug-in module for each voice or data channel. The remainder of the Bush earth station consists of a 3.6-meter offset-fed antenna, (the smallest which meets regulatory requirements regarding adjacent satellite interference), an integrated receiver-transmitter package, a monitor and control system, and a power system. All electronics are housed in two specially designed shelters; each about the size of an average refrigerator. The antenna and shelters are mounted to a load frame which is weighted with locally available gravel to prevent overturning by wind. Figure 5 and Photo 1 show a typical Bush earth station installation. Figure 6 is a block diagram of the WARP electronics.


ICE/CABLE BRIDGE
POWER SHELTER
COMMUNICATION EQUIPMENT SHELTER
3.6 METER OFFSET FEED ANTENNA
BALLAST MATERIAL

WARP PLOT PLAN

FIGURE 5


C.O. REPEATER
T1 LINE INTERFACE
CH 1A
CH 1B
CH 2A
CH 2B
CH 3A
CH 3B
CH 4A
CH 4B
CH 5A
CH 5B
CH 6A
CH 6B
CH 7A
CH 7B
CH 8A
CU A1
CU A2
CU A3
CU A4
CU A5
CU A6
CU A7
CU A8
CU B1
CU B2
CU B3
CU B4
CU B5
CU B6
CU B7
RSCU
Σ
IDU IF
IDU RF
ODU
OMT
CU – CHANNEL UNIT
RSCU – REMOTE SIGNALLING CHANNEL UNIT
ODU – OUTDOOR UNIT (TRANSMITTER)
IDU – INDOOR UNIT (RF CONVERTER)
OMT – ORTHOMODE TRANSDUCER

WARP BLOCK DIAGRAM

FIGURE 6

The electronics shelter is fabricated of aluminum for low weight and durability. It employs three separate cooling systems to maximize reliability and reduce power consumption. The cooling systems (radiant, heat-exchanger, and air conditioner) all prevent outside air and contaminants from reaching the interior of the shelter, thus precluding damage from moisture and dirt.

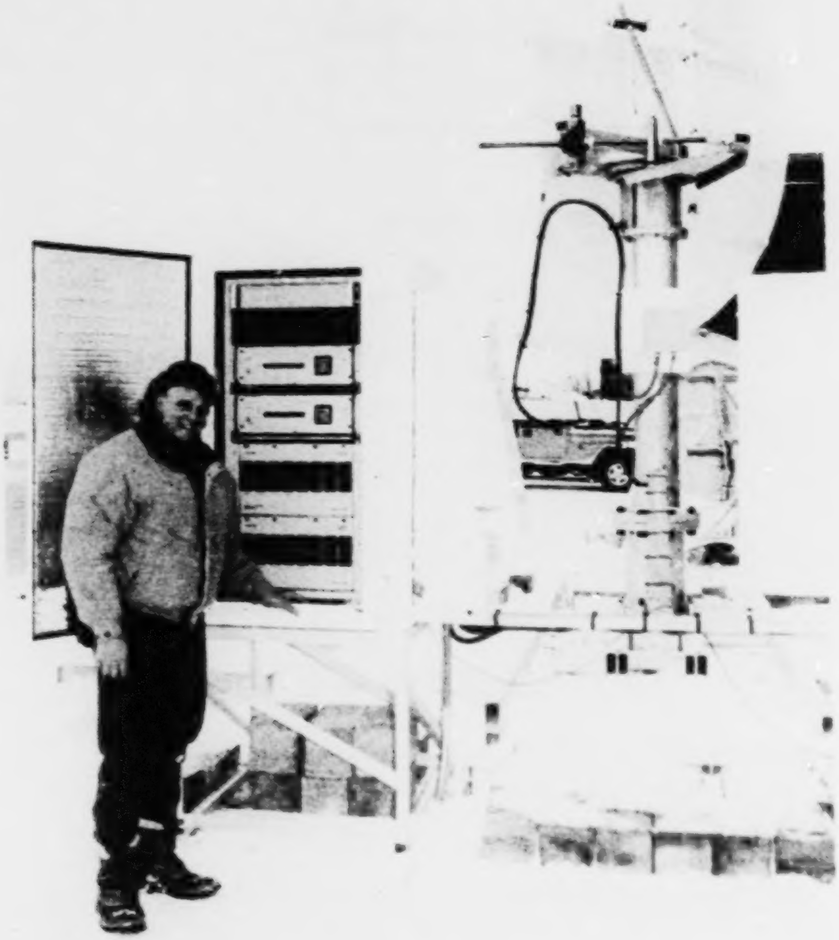


Photo 1: Richard P. Dowling, GCI

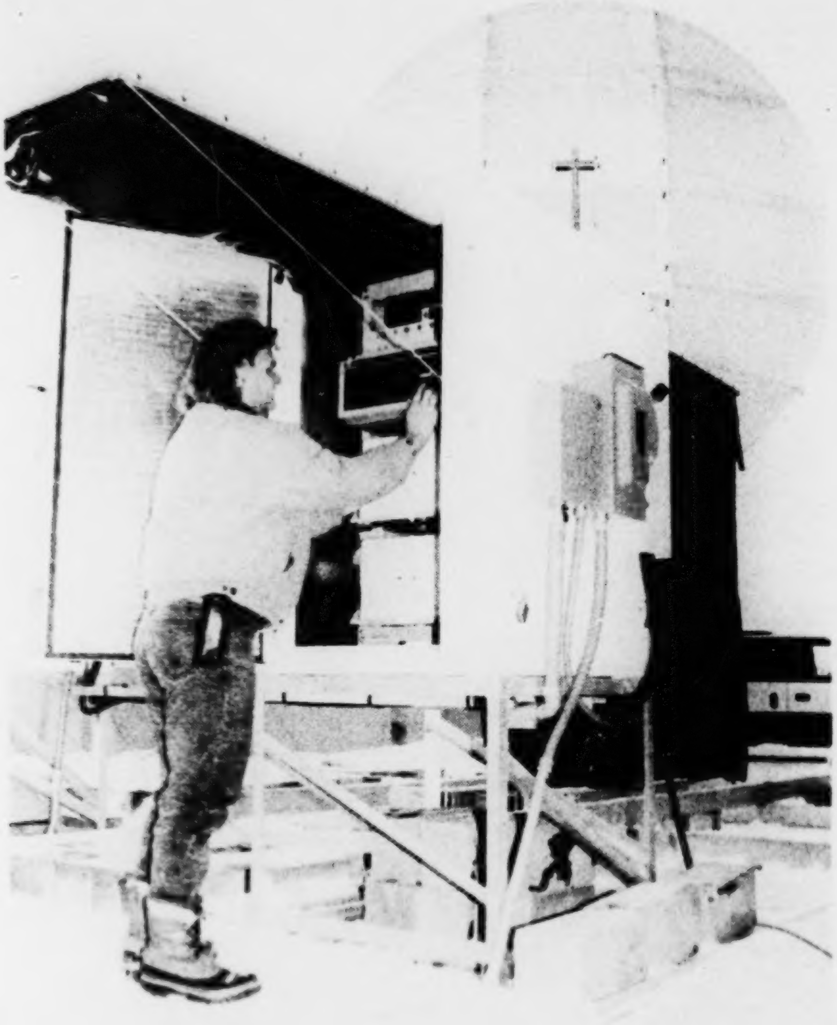


Photo 2: Richard P. Dowling, GCI

A tent-like enclosure drops down around maintenance personnel before the enclosure is opened. This tent protects both the person and the equipment from the elements. (Photo 2 shows an open shelter with its tent in position.) The shelter has front and rear doors, automatic interior lighting, and a raised mount to give easy access for maintenance. Power system components are contained in a nearly identical shelter positioned near the electronics and include battery back-up to commercial power.

The WARP hardware is designed to be manufactured rather than constructed at the earth-station site. Each station is identical except for the number of channel units, and each contains units which can be manufactured in quantity at lower cost than if constructed on site. Because the basic configuration of all stations is the same, they are immediately familiar to maintenance personnel. Further, all components, including cables and mechanical components can be replaced from stock rather than re-created in the field.

The entire Bush earth station can be carried in two or three loads in a Cessna Grand Caravan aircraft, commonly available throughout Alaska. Many other aircraft are also suitable. A crew of two experienced workers, supplemented by local labor, can deploy and commission a station in less than one week. The earth station components, including the antenna, can be assembled with ordinary hand tools, requiring no special equipment.

Operation and Maintenance

The WARP operations and maintenance philosophy enables the goal of near-urban levels of system availability to be achieved. Maintenance issues are addressed in the following ways:

- Comprehensive diagnostic information is available remotely through a monitor and control channel on the satellite. This information includes internal module parameters, many of which can be remotely altered for maintenance purposes, as well as environmental status, plus parameters such as inside and outside temperatures, power plant voltage, current, etc. This allows human and computer surveillance of all sites from an operations center which is staffed with highly qualified specialists. The same data and control capabilities are available on site via a notebook computer attached to a local data port. (Figure 7 shows a typical high-level information screen available to operations personnel. Many detailed subsidiary screens comprising several thousand parameters for each remote station can be viewed by successively clicking on their icons.)

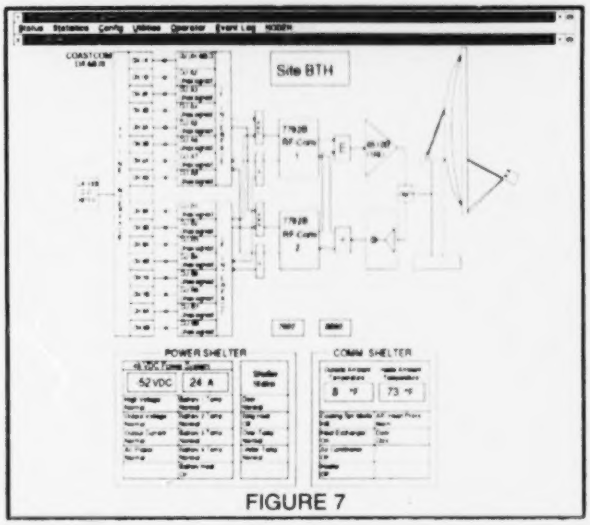


FIGURE 7

- Any of WARP's five major electronics modules can be replaced without need for any field adjustment. All location-specific parameters are stored in a central database and downloaded to the module. This feature eliminates both the need for test equipment in the field and human error in setting up a module. Overall network quality and reliability are enhanced significantly, because network configuration is engineered and will remain stable over time, regardless of maintenance activity.

- All channel modules are identical. The personality of a channel unit is derived from the software loaded into it over the satellite after its particular location is determined by the central controller. Functionality, therefore, follows position in the network, and any channel unit will assume a given functionality when installed in a given position. Thus, a channel unit may serve as a voice or data channel, depending on which network position it occupies. Moreover, it may operate with a variety of voice and radio frequency coding schemes or as a data channel at any of many data rates.

Because field maintenance consists of replacing failed or questionable modules, highly-qualified technicians will seldom be needed. Field work is primarily a logistics effort requiring no great technical skills. In Alaska the

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appropriate personnel to do this work are the pilots who have traditionally flown the technicians to the site. These pilots are technically competent, skilled in Bush logistics, and familiar with the local people and their customs. They are located all over the state and are readily available, whereas it is difficult and expensive to maintain a staff of qualified technologists outside urban areas. GCI will employ former air taxi pilots who fly their own aircraft to provide logistics support to a centralized technical staff. They will make frequent visits to each earth station location for preventive maintenance checks and to assess the integrity of the site. A local person will be employed part-time to take care of any day-to-day activity and to maintain a company presence in each village.

Conclusion

Taken together, the elements of GCI's program for rural service delivery represent a radical departure from past methods and practices. The benefits of reconceptualizing all aspects of long-distance service delivery to remote locations will be demonstrated at 50 villages in Bush Alaska this year, when the company installs and implements a system incorporating the manufacturing concepts and operational methods described above.

The WARP system provides for high-speed data-on-demand services. These will make it possible for rural Alaska to enjoy advances in telecommunication applications such as distance learning, telemedicine, desk-top video conferencing, and computer linking. The destination of a data-on-demand call can be anywhere on the network, not just at a single remote loction as offered in the dedicated circuit model. Thus, data-on-demand will allow users to pay for only the time they use the service, rather than the traditional month-to-month cost of dedicated high-speed data channels. Further, WARP will allow rural residents to achieve economic and social goals more readily than ever before, because historic barriers to efficient access to modern telecommunications will be eliminated.

As in Alaska, isolated populations, low-density communications requirements, and a need for advanced telecommunications services exist in the Pacific and many other parts of the world. Most of the solutions to the problems addressed by WARP—and the concepts and process that produced it—are, with appropriate adaptation, transferrable to other areas with similar characteristics.

423

Call/Connection Control in ATM Switching System for Multimedia Service

Seunghee KIM, Moonkyun OH, Misook HAN and Hankyoung KIM
Multimedia Call Control Section, ETRI, Taejon, Korea

ABSTRACT

Diverse call/connection control is one of the most important part in ATM switching system for multimedia service. In this paper, we propose the B-ISDN call/connection control by using scenario control algorithm, process instance identifier succession, shared library. We also define the necessary components for the cell routing control in the self-routing switch and propose the cell handling principle at the point-to-point and point-to-multipoint connection. ATM switching system with this control schemes can provide urgently demanded B-ISDN service and accommodate new services easily.

1. INTRODUCTION

As the need for good quality multimedia communications services including data, voice and video has increased, the research on high speed networks and signaling protocols is getting more attention than ever. One major issue for public telecommunication network is to find an important technology to handle the transport and switching of all types of service within a common infrastructure. The advent of ATM(asynchronous transfer mode) technology has provided network operators not only with the capability to meet the ever increasing bandwidth requirements of their customers but also with a flexible resource that will enable service to be provided as efficiently as possible.

The existing telephone and data communication service is supplied by only PtP(point-to-point) call/connection control. But, for multimedia service provision, it is necessary for the PtMP(point-to-multipoint) call/connection control, multiple connection control and connection modification.

Large switching system have the characteristics of real-time processing, long system life, inevitable requirements change and managing complexity. Therefore performance enhancement, flexible service control, easy maintenance and structural management method must have critically considered in ATM switching system.

The call/connection control for the various signaling capabilities is one of the most important parts in ATM switching system. The actual call/connection control would be operable only after the complete integration of various blocks and definite interfacing between hardware and software.

In this paper, we propose the B-ISDN call/connection control by using scenario control algorithm for enhancement of reusability and maintenance, PID(process instance identifier) succession for the flexible interaction between diverse service control processes, shared library for the effective data share between modules. We also define the necessary components for the cell routing control and describe the operation of cell flow at the PtP and PtMP connection in ATM switching system.

This paper is organized as follows. Chapter 1 is introduction. Chapter 2 discusses current international B-ISDN signaling capability and signaling requirements for multimedia services. ATM switching system architecture is presented and B-ISDN call/connection control method is proposed in chapter 3. In chapter 4, we also define the necessary components for the cell routing control and describe the operation of cell flow at the PtP and PtMP connection in ATM switching system. Finally we conclude it in chapter 5.

2. B-ISDN SIGNALING CAPABILITY

ITU-T and ATM Forum have been actively participating in the international standardization of UNI(user network interface)/NNI(network node interface) B-ISDN signaling. The terms of Release 1,2,3, Capability Set 1,2,3 and Phase 1,2 refer to a stepwise approach to B-ISDN service provision. In consideration of this stepwise approach, we think, the multiple party and multiple connection control, cell copy function, traffic parameter negotiation and bandwidth modification function are requisite for B-ISDN services especially.

For PtP call/connection, it is required the signaling capability such as switched virtual channel connection, symmetric/asymmetric bandwidth control, unidirectional/bidirectional connection, simultaneous call/connection establishment procedure, out-of-band signaling for all signaling messages and signaling interworking for N-ISDN services provision.(1)

For PtMP call/connection, it is required the signaling capability such as the only type 2 connection topology support, explicit request for PtMP call with the broadband bearer capability parameter, a new leaf addition and the call release by the only root, the connection establishment between the first party and the second party by sequential adding method and the leaf drop from the call by itself.(2,5)

For multiconnection, it is required the signaling capability such as the only type 1 connection topology support, explicit request for multiconnection call with connection reference, the connection addition request by either calling user or called user, connection addition /deletion one by one to the existing call and release the call and all connections at the same time.(3,5)

The traffic parameter negotiation in call establishment phase or call active phase may be required by user demand. For connection modification, it is required the signaling capability such as only the PtP connection modification, only the peak cell rate modification, connection modification one by one to the existing call and no rerouting in the network.(4,5)

3. ATM SWITCHING SYSTEM

3.1 ATM Switching System Architecture

ATM switching system is composed of distributed architecture for real-time processing and hot standby dual system for reliability enhancement. it is also composed of self-routing switch for high speed cell exchange and diverse rate access link interface such as STM-1, STM-4, DS-3, DS-1E level. And it is modular architecture to meet a variety of growing demands such as heterogeneous traffic application, versatile signaling capability and increasing capacity.

In order to transfer user information and control signal, transport network consists of switch network part, interface part and network synchronization part. Switch network part fulfills the role of self-routing switching and switch link interface. Interface part fulfills the role of user and network interface. Network synchronization part fulfills the role of network synchronization and system clock generation. Besides, control network consists of call processing part, signaling handler part, operation and maintenance part and inter module interface part. An information exchange is achieved through switch network of transport network.

So as to control characteristics of an unpredictable and burst traffic and to accommodate diverse user demand effectively, traffic control mechanism is essential in ATM network.(6)

CAC(connection admission control) and RM(resources management) at call processing part negotiate traffic descriptors between user and network and reserve bandwidth for VP(virtual path)/VC(virtual channel) connection so that the QOS is guaranteed. UPC(usage parameter control)/NPC(network parameter control) at access link interface part monitor the user traffic and accept or discard the cell traffic to guarantee the network QOS. PC(priority control) at switch network part may discard cells with low priority by using the cell loss priority bit if it is necessary to protect as far as possible the network performance for cells with high priority. CC(congestion control) at operation and maintenance part assists the network in avoidance of and recovery from a congested state by using explicit forward congestion indication mechanism. Figure 1. describes the ATM switching system architecture.

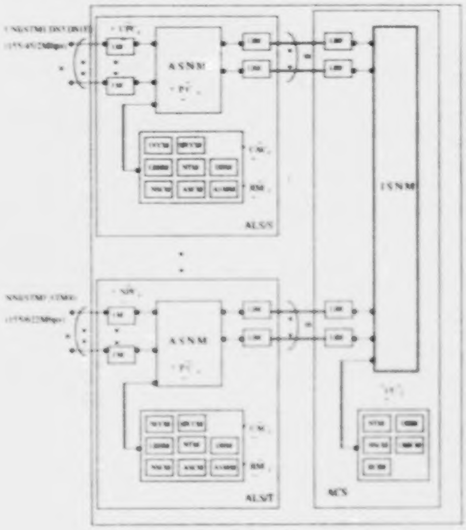


Figure 1. ATM SWITCHING SYSTEM ARCHITECTURE

UCCM:User Call Control Module
NCCM:Network Call Control Module
SPCCM:Semipermanent Connection Control Module
LRHM:Link Resources Handling Module
NTM:Number Translation Module
DHM:Data Handling Module
NSCM:Network Synchronization Control Module
ASCM:Access Switching Control Module
ASMM:Access Switching Maintenance Module
OMCM:Operation and Maintenance Control Module
RCIM:Remote Control Interface Module
IM:Interface Module
LIM:Link Interface Module

ASNM Access Switching Network Module
ISNM Interconnect Switching Network Module
ALS/S ATM Local Switching Subscriber Subsystem
ALS/T ATM Local Switching Trunk Subsystem
ACS ATM Central Switching Subsystem

3.2 Call Processing Software Design

For the interworking of an existent public network and customer premise network, call/connection control of switching system should be design to support the diverse signaling protocol conversion function easily and to adopt new signaling protocol flexibly. In order to enhance software quality and productivity, software specification and component procedure in development phase is very important. We have made an effort to increase software reusability in source program coding and design phase by using the scenario control algorithm.
The ATM switching system consists of various function modules each corresponding to a particular function. These function modules can be combined into a building-block-like structure according to the required size and particular functions of the switching system. This architecture facilitates expansion of both system size and functions.(7)
Each block is developed, loaded and traced independently from others. By layering of resources management layer, connection control layer and call control layer, we can minimize the interactions between layers from functional change. And we can also maintain independence of block by explicitly manifesting interfaces.
Call processing function is accomplished by interworking between multiple modules. UCCM performs the layer 2,3 interfaces and call/connection control function on the basis of the Q.2931 user signaling protocol. NCCM performs the layer 2,3 interface and call/connection control function on the basis of the B-ISUP network signaling protocol. SPCCM performs the semipermanent connection control through human machine interface. LRHM performs the allocation/deallocation of UNI/NNI link resources, internal switch link resources and VPI(virtual path identifier)/VCI(virtual channel identifier). NTM performs the translation of subscriber number. DHM performs the management of office data and system configuration data.
Call processing program is implemented with CHILL(CCITT high level language). CHILL module consists of an information encapsulation with data and procedure definitions. Dynamic process, as an unit of concurrent processing, is created or stopped in accordance with application demands. Information transfer is performed by message communication. Critical region function is supported to solve data inconsistency problem.
In addition, we have been simultaneously propelling research and development on object oriented CHILL and software development environments. An object oriented methodology provides greater understanding of the system because it maps real world objects to the problem domain. And this helps to minimize the impact of changing system requirements by minimizing perturbation to objects.

3.3 B-ISDN Call/Connection Control

The design of call processing function is mainly composed of the state transition, message and action routine definition. The messages are the sets of signaling protocol message type. The action routines are the sets of call/connection processing procedure in accordance with each state and each message type. And the state transition is flow between current state and next state in accordance with received message type.
We design the scenarios to act in accordance with an event, which consists of a set of procedures or other scenario. During requirements analysis and design phase of software engineering paradigm, the documentation of scenario and procedure function must be accomplished and can be reused for another services. Figure 2. describes scenario control algorithm.

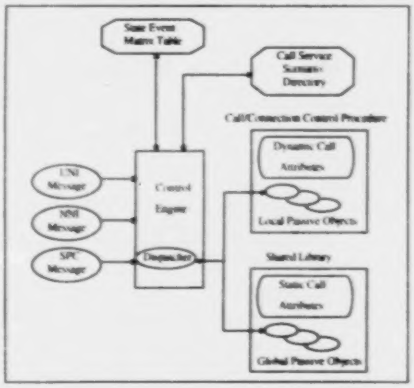


Figure 2. SCENARIO CONTROL ALGORITHM

Various call processing process is designed for diverse service provisions, and information share between processes has done through message communication. In consideration of finite state transition machine concept, we proposed the scenario control algorithm for B-ISDN signaling and semipermanent connection control. Receiving UNI/NNI signaling message and semipermanent connection control message, control engine creates concurrent call handler process and transfer the message to it for call processing. An appropriate scenario is picked up from state event matrix table with reference to current call/connection state and message type received. control engine schedules the call flow in accordance with the result of procedure processed. Even when additional signaling function is taken into for new service insertion and existent network interworking, the most part of our call/connection control function can be still reused.

The call control process design is very important to satisfy real-time processing and quality of service requirements in ATM switching system. In case of process definition, the process creation/stop timing point, the performed functional scope within one process and the capability for functional insertion and modification must be considered. To meet new service demands effectively, control transfer mechanism is necessary for interworking between diverse call control processes. For the transition between services, call control process is needed to transfer the control into the call control process pertaining to the other service category.

But control handover procedure is considerably complex and it is necessary to handle the abnormal status procedure duration control handover. The basic reasons of complexity are the differences between identifier of previous call processing process instance and that of new created call processing process instance. To solve this problem, we propose PID succession method through the PID inheritance used the previous call control PID in case of call control process creation for new category service. The newly created process can use the previous processing data located in shared data area again by using the unique call index. In this way, simple transition procedure makes it possible to minimize complexity in call control function, to enhance performance and to accommodate new service flexibly.

For example, when the setup message is received to establish the call/connection, PtP call/connection control child process is created. It investigates the contents of broadband bearer capability information element in setup message to determine call/connection type is PtMP. If call/connection type is PtMP, PtMP call/connection child process is created by using PID succession method.

3.4 Data Share Method

Shared library is proposed as one of the interface method to an effective data share between multiple modules. This is the access method to directly indicate the physical address of global data and text to be used. Shared library is not involved in the user program area, and it is located at the fixed memory area in processor as a result of negotiation with operating system. It is executed in run time through shared library interface.

Data for ATM switching system is categorized mainly into static data and dynamic data. Processor loading data consists of office installation data and system configuration data. Feature traffic data and resources management data such as UNI/NNI link, internal switch link and VPI/VCI connection identifier control data are located in global area of processor. These data must be assured of consistency in simultaneous usage of multiple modules.

By the access through shared library, we can achieve an early trouble solving by data visibility and audit. In addition, we can also achieve performance enhancement by minimization of message to be exchanged.

4. ATM CELL ROUTING CONTROL

4.1 ATM Cell Routing Control Components

ITU-T SG 11 classifies the CTT(connection topology type) for B-ISDN services into 5 types.(8) CTT1, PtP connection is a unidirectional or bidirectional connection between two terminals. CTT2, PtMP connection is a unidirectional connection from a single source to two or more sinks. CTT3, MPtP connection is a unidirectional connection from two or more sources to a single sink. CTT4, MPtMP connection is a connection in which each of parties act as both source and sink so that each is receiving an orderly combination of information sent by every other party. CTT5, PtMP connection is a bidirectional connection from a single source to two or more sinks.

The number of parties involved in a call(one-to-one, one-to-many, many-to-many) and information flow direction(unidirection, bidirection) is used with criterion of connection topology classification. The only CTT1 and CTT2, is the scope of current implementation. CTT2 connection control by cell copy function of ATM switch, may support multicasting service. The source of the multicast connection will always be aware of all parties to which the connection travels.

In accordance with the result of call/connection establishment or release procedure by signaling processing, cell routing information is inserted or deleted at cell header conversion table in interface module memory. Cell header conversion table consists of input cell header conversion and output header conversion table. For PtP connection, only input cell header conversion table is used. But, for PtMP connection, not only input cell header conversion table but also output cell header conversion table are used for multicasting.

ATM cell format at UNI/NNI link, consists of 53 octets with header and payload part. For the cell routing within ATM switching system, this cell format must be transformed into 56 octets internal cell format with added self-routing switch control information. ATM cell routing control components for input cell header conversion at PtP connection, consist of IDL, MTC, CDP, CET, OrigASW, CSW and DestASW. Besides ATM cell routing control components for input cell header conversion and output cell header conversion at PtMP connection, is needed MCN additionally. Figure 3. describes an internal cell format at PtP connection and Figure 4. describes an internal cell format at PtMP connection.

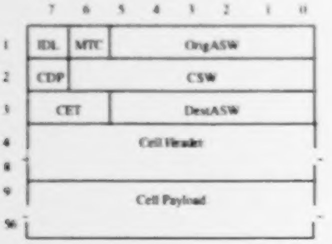

7 6 5 4 3 2 1 0
1
2
3
4
8
9
56
IDL
MTC
OrigASW
CDP
CSW
CET
DestASW
Cell Header
Cell Payload

Figure 3 INTERNAL CELL FORMAT AT PTP CONNECTION

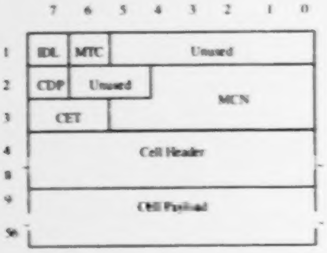

7 6 5 4 3 2 1 0
1
2
3
4
8
9
56
IDL
MTC
Unused
CDP
Unused
MCN
CET
Cell Header
Cell Payload

Figure 4 INTERNAL CELL FORMAT AT PTMP CONNECTION

IDL Idle Cell Identifier
MTC Multicasting Cell Identifier
CDP Cell Delay Priority Identifier
CET Cell Type Identifier
OrigASW Origination Access Switch Port Address
CSW Central Access Switch Port Address
DestASW Destination Access Switch Port Address
MCN Multicasting Channel Number

4.2 Cell Flow Procedure at PtP Connection

By VPI/VCI indexing of received cell header, self-routing switch control information is selected from the input cell header conversion table. And input 53 octets cell format is transformed into internal 56 octets cell format.

The self-routing control information of each PtP connection consists of cell type, origination access switch output port address, central switch output port address, destination access switch output port address and output VPI/VCI. In accordance with routing control information, each stage of self-routing switch is operated with hardware action and output interface module deletes the inserted 3 octets. Therefore, information cell transfer at PtP connection is achieved by single input cell header conversion. Figure 5. describes cell routing procedure at PtP connection

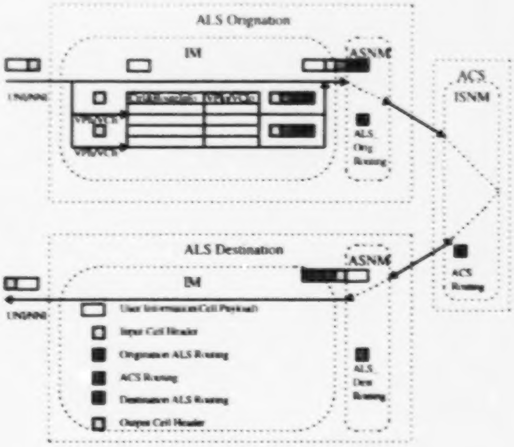

ALS Orignation
IM
ASNM
UNI/NNI
VPI/VCI
VPI/VCI
ALS_
Orig
Routing
ACS
ISNM
ALS Destination
IM
ASNM
UNI/NNI
ACS
Routing
ALS_
Dest
Routing
User Information(Cell Payload)
Input Cell Header
Origination ALS Routing
ACS Routing
Destination ALS Routing
Output Cell Header

Figure 5. CELL ROUTING AT PTP CONNECTION

4.3 Cell Flow Procedure at PtMP Connection

By VPI/VCI indexing of received cell header, MCN and connection control information are selected from the input cell header conversion table. And input 53 octets cell is transformed into internal 56 octets cell format.

Input VPI/VCI is transformed with output VPI/VCI by MCN indexing at output interface module. Cell copying in ATM switching system occurs on the base of switch port. Self-routing switch control information to be activated is resident at MRM(multicasting routing memory) in access switch and central switch controller. In accordance with add or drop of party, output cell header conversion table and MRM are updated.

The self-routing control information of each PtMP connection consists of cell type, MCN, MRM and output VPI/VCI. In accordance with routing control information, each stage of self-routing switch is operated with hardware action. And output interface module performs output cell header conversion and deletion of an inserted 3 octets.

Information cell transfer at PtMP connection is achieved by single input cell header conversion and single output cell header conversion. Figure 6. describes cell routing procedure at PtMP connection.

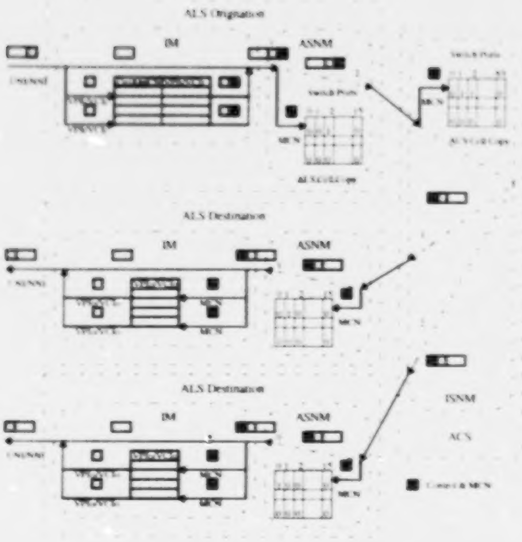


Figure 6 CELL ROUTING AT PTMP CONNECTION

5. CONCLUSION

The current B-ISDN signaling requirements and signaling capability in ATM switching system for diverse multimedia service provisions were investigated. We propose the B-ISDN call/connection control by using such as the scenario control algorithm for the flexible call/connection control processing, the shared library for the data share between modules, the process instance identifier succession for the interaction between diverse service control processes. We also define the necessary components for the cell routing control in the self-routing switch and propose the cell handling principle at the point-to-point and point-to-multipoint connection in ATM switching system.

The ATM switching system with this control schemes can provide urgently demanded B-ISDN service such as high speed data transfer, high speed computer communications, video conference service and video on demand service.

We have been implementing the proposed techniques necessary for new services. But there are still some issues to be resolved before fully realizing the diverse services. The issues include the multipoint-to-multipoint call/connection control, multipoint-to-point call/connection control, cell merging function, timing synchronization between multimedia and traffic descriptor negotiation. The services will, however, be provided step by step considering the progress of international standardization.

[REFERENCE]

(1) ITU-T SG11, *"B-ISDN DSS2 UNI Layer 3 Specification for Basic Call/Connection Control"*, Draft Recommendation Q.2931, September 1994.

(2) ITU-T SG11, *"Draft Recommendation Q.2971 PtMP Call and Connection Control"*, Draft Recommendation Q.2971, May 1995.

(3) ITU-T SG11, *"User Network Interface Layer 3 Specification for PtP Multiconnection Call Control"*, Draft Recommendation Q.298X, May 1995.

(4) ITU-T SG11, *"B-ISDN DSS2 Connection Modification"*, Draft Recommendation Q.2963, May 1995.

(5) ITU-T SG11, *"Generic Concepts for the Support of Multipoint and Multiconnection Calls"*, Draft Recommendation Q.293X, May 1995.

(6) ITU-T SG13, *"Traffic Control and Congestion Control B-ISDN "*, Temporary Document, March 1994.

(7) Noriharu Miyaho, Miki Hirano, Yasushi Takagi, Kohei Shiomoto and Tatsuro Takahashi, *"An ATM Switching System Architecture for First Generation of Broadband Services"*, ISS'92, A3.2, pp. 285-289 October 1992.

(8) ITU-T SG11, *"Broadband Capability Set 2 Signaling Requirements"*, Temporary Document, December 1993.

Demand Forecast and Technologies Development on ATM Switching Systems in Korea

Byungryong Kang, Sungyeol Kang, Chimoon Han, and Chuhwan Yim
Switching Technology Division, ETRI, Taejon, S. Korea

1. ABSTRACT

We are actively working on the development of ATM switching systems, as a major part of B-ISDN project in Korea. This paper introduces the overall description of an experimental ATM switching systems under development, and presents the results of a case study on the forecast for ATM based B-ISDN penetration to analyze the transition process from existing switching systems to ATM systems.

2. INTRODUCTION

Nowadays technological changes in telecommunication are mainly driven by the enhancement of ATM technology. ATM allows the integration of multiple applications in a seamless infrastructure and achieves economies of scale through a better integration of various traffic types such as video, data, image and voice.

Some institutes and network operators have studied a mid and long term strategy to evolve its network to be adaptable to the future broadband network. A major part of the B-ISDN network development is for the development of ATM switching systems. We have already developed digital switching systems for PSTN and their variants for different network environments. They have been refined in an evolutionary manner so that they can be employed for integrated services digital networks, intelligent networks, and public land mobile networks. With the technological knowledge and experiences obtained through the fulfilling accomplishments in the development of digital switching systems, we are moving forward to meet the switching demand of broadband services.

In this paper, we introduce the research and development activities on ATM switching systems, and presents one of the experimental results of feasibility study on the marketability for ATM switching systems in our competitive market environments. One of the major effort in our work is mainly focused on the ATM based B-ISDN diffusion rate in the domestic telecommunication market. We start with a brief description of the ATM based B-ISDN network, and explain our major activities for developing ATM switching systems, their general structures and functional capabilities. We then presents theoretical framework and assumptions employed for forecasting demand for ATM based B-ISDN applications, and forecasting results for the diffusion rate of B-ISDN, and aggregate domestic ATM market.

3. B-ISDN NETWORK DEVELOPMENT PROJECT

Major telecommunications research institutes, network operators, communication manufacturers, and universities jointly participate in the B-ISDN project such that we can utilize efficiently the limited human and financial resources for it. The tasks and responsibilities that the project entails are shared among them, depending on their specialties and advantages. The research institutes are responsible for developing base technologies and implementing experimental systems. The network operators are involved in extensive field trials of the experimental systems on network testbeds and developing application services. The manufacturers take charge of refining the experimental systems to upgrade their performance and developing manufacturing technologies for the competitiveness of their commercialized products. The universities are mostly working on lots of fundamental research issues in ATM-based B-ISDN technologies.

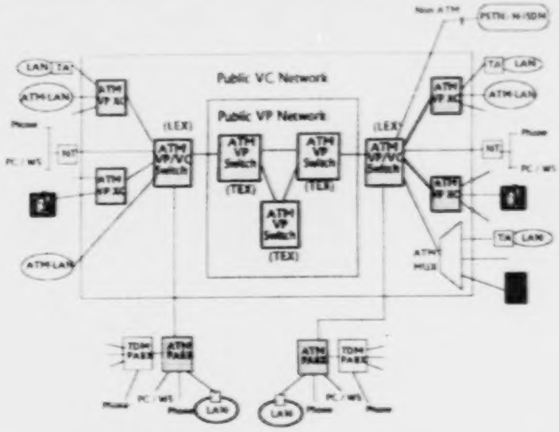
This activities embrace several R&D areas of ATM-based B-ISDN technologies such as network integration, switching systems, transmission systems, and terminal equipments. It will be accomplished over the following four phases.

- Phase 1: We carry on fundamental studies for ATM-based B-ISDN. We develop experimental models of small-scale ATM switching system and other B-ISDN elements.
- Phase 2: We refine the experimental models, adding functional features to them. We establish a network test bed, which serves as an initial environment for testing the R&D products in the project and for creating multimedia services to be provided by B-ISDN. We then build up an initial B-ISDN network of mostly leased-line services that can provide high-speed data services

for business subscribers on a trial basis.

- Phase 3: We acquire most of fundamental technologies for the realization of ATM-based B-ISDN, including technologies for large-scale ATM switching systems and high-quality multimedia terminal equipments. We conduct field trials for providing public subscribers with high-speed data services, high-quality video services and other multimedia services. We also put forth our efforts on the penetration of B-ISDN services into public users.
- Phase 4: We finish up developing all the technologies required for ATM-based subscriber premises networks and backbone networks. We make more provisions of B-ISDN services available to public users.

Figure 1 visualizes a conceptual configuration of ATM-based broadband communication network. As we can see here, it consists of many network elements such as switching systems, cross-connectors, network terminations, inter-working units, terminal equipments. We expect most of those network elements should be available in late nineties as the outcomes of our activities. As the results, the various communication services would be hopefully getting more and more accommodated by ATM-based broadband communication networks in the early next century.



LAN : Local Area Network	TEX : Transit Exchange
LEX : Local Exchange	VC : Virtual Channel
NT : Network Termination	VP : Virtual Path
TA : Terminal Adapter	XC : Cross Connect

Figure 1. A Conceptual Configuration of ATM Network at Final Stage

4. DEVELOPMENT OF ATM SYSTEMS

4.1. SYSTEM DEVELOPMENT STRATEGIES

ATM switching technology is considered as one of the key elements necessary for establishing broadband communication networks. As such, the development of ATM switching systems is a major part of the B-ISDN network development. A small scale version with 10 Gbps throughput will be developed during first stage. It will be developed in stages in such a way that it may serve as just a virtual path switching system initially and also as a virtual channel switching system later. Our major research activities during this phase will be stressed on getting key ATM switching technologies. The development of the large-scale version with several hundreds Gbps throughput is scheduled to be completed in stage 3.

R&D institutes, network operators, several local manufacturers, and quite a few universities are jointly working on the R&D activities of ATM switching systems. R&D institute is in charge of developing base technologies for ATM switching systems and implementing experimental models. Network operator is involved in extensive experimental trials of the ATM switching systems on network testbeds. The manufacturers take charge of improving the experimental models and commercializing them. The universities study mostly fundamental issues related to ATM switching systems.

4.2. SYSTEM STRUCTURE AND CAPABILITIES

In this section our discussion will be focused mainly on the small-scale experimental ATM switching system. The specifications of the ATM switching system to be developed are in Table 1.

Table 1. System Specifications

UNI Line Type	SDH-based STM-1, DS3/DS1E
Interface Rate	155.52Mbps, 44.74 Mbps/2.048Mbps
Frame Structure	ITU-T G.709, F.704
Cell Mapping Format	ITU-T I.432, G.804
Cell Format	ITU-T I.361
Switch Network Throughput	> 9.9Gbps
UNI Link (155Mbps based)	Max. 56 Links
Maximum Vitual Connections/Link	2048 connections
Signalling	HCSI(Q.2931+ , B-ISUP+)
Addressing Format	ITU-T E.164

Figure 2 shows the conceptual configuration of the ATM switching system. The transport network of the system consists of three parts which are for ATM cell switching, for interfaces with subscriber lines and trunk lines, and for network synchronization and clock generation respectively. The switching network part is again composed of access switching network modules and interconnection switching network modules. The control network of the system consists of four parts for call processing, signaling handling, number translation, and maintenance and operation respectively. An internal protocol, named IMI (Inter-Module Interface), is used to connect the modules in the system each other.

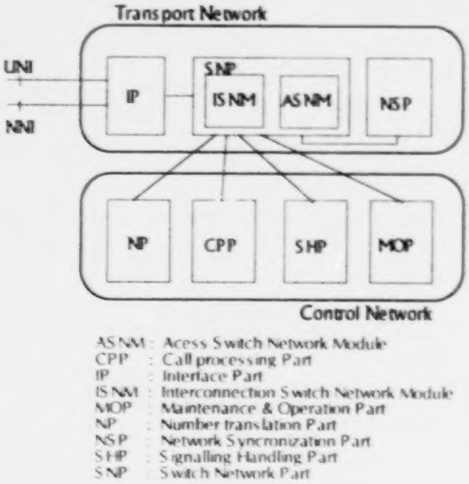

Transport Network
UNI
NNI
IP
SNP
ISNM
ASNM
NSP
NP
CPP
SHP
MOP
Control Network
ASNM : Acess Switch Network Module
CPP : Call processing Part
IP : Interface Part
ISNM : Interconnection Switch Network Module
MOP : Maintenance & Operation Part
NP : Number translation Part
NSP : Network Syncronization Part
SHP : Signalling Handling Part
SNP : Switch Network Part

Figure 2. Conceptual System Configuration

The entities in the control network communicate each other through the transport network itself, without a separate IPC network, as shown in Figure 3. So, the information traffic between the control entities of the system can be conveyed using the same ATM cell format as user traffic. This results in a simplification of interface in the system which facilitates to interconnect its function blocks and to add new functional features. The switching system consists of access switching subsystems and central interconnection subsystems. It is configured into a modular structure with distributed control mechanisms to facilitate expansion and future adaptation.

The access switching subsystems perform UNI and NNI interface functions and ATM cell switching functions. The user interfaces cover STM-1, DS1E, and DS3, and the NNI includes STM-1 and STM-4. Each access switching subsystem is designed to have local call switching and concentration functions. It has call processing, traffic management, and local M&A capabilities so that calls can be handled in a fully distributed fashion. The central interconnection subsystems are designed to function as a simple passive switching network for the interconnection between access switching subsystems.

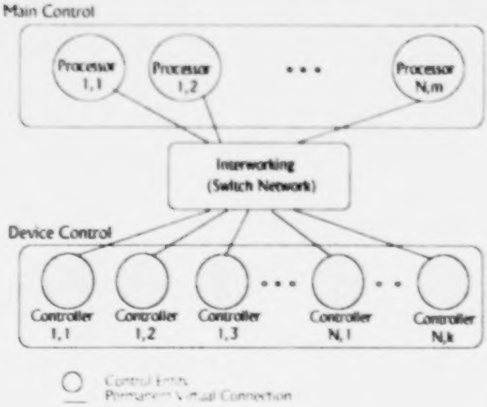

Main Control
Processor 1,1
Processor 1,2
Processor N,m
Interworking (Switch Network)
Device Control
Controller 1,1
Controller 1,2
Controller 1,3
Controller N,1
Controller N,k
Control Entity
Permanent Virtual Connection

Figure 3. Conceptual Structure of Control System

The switching system also includes conventional digital switching subsystems, which are connected to the access switching network module through internal inter-module interface. They may be helpful to accommodate existing POTS subscribers.

The switching network is composed of three stages, using single-folded self-routing switch elements. Figure 4 presents a configuration of the switch element which resides in access switching subsystems. It is designed to be applicable to subscriber concentration. The concentration ratio can be adapted to traffic conditions from 1 : 1 to *n* : *m*, where *n* is the number of ports assigned for user interfaces and *m* is the number of ports assigned to the central switch. One port is reserved for signaling and control traffic.

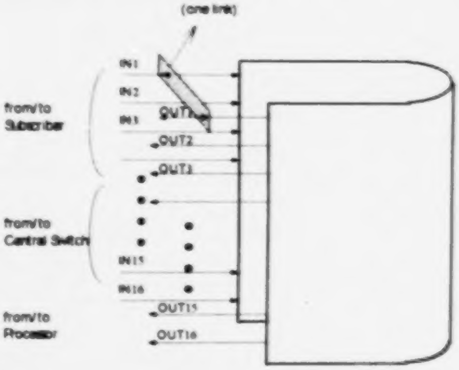

(one link)
IN1
IN2
IN3
OUT1
OUT2
OUT3
IN15
IN16
OUT15
OUT16
from/to Subscriber
from/to Central Switch
from/to Processor

Figure 4. A Configuration of Switch Element

The switch element employs a common memory with a partial buffer sharing scheme for the priority control of cell buffering in it. The switch element block consists of input traffic multiplexing part, common memory part, output traffic multiplexing part, priority control part, unicast or multicast routing control part, and processor interface part.

5. THE FRAMEWORK FOR FORECASTING DEMAND

In the areas of marketing and technological changes, many researchers have given their attentions to linear combinations or modifications of some basic models (like the exponential, logistic model) and the time-varying nature of the diffusion coefficient, as well as the influence of dynamic potential adopters on diffusion process.

Some of the relations between the logistic curve and the Gompertz curve has been investigated by the Sharif-Kabir model including the Floyd curve, which has analytical properties similar to the Gompertz curve. The logistic curve is known as the Pearl curve (or Pearl-Reed curve)[11]. The Mansfield model[10], the Blackman model[2] and the Fisher-Pry model[5] are actually slight modifications of Pearl curve, and the NSRL model[3] is a type of NUI model[4], which is enhanced from the Bass model[1]. The NUI model and NSRL model are same with the Bass model except adding an exponent δ in order to give flexibility in choosing the inflection point in the Bass model. Sharif and Islam[12] suggest the Weibull distribution as a general model for forecasting technological change. This Weibull distribution model (or Sharif-Islam model) is based on Weibull distribution function, which can accommodate different patterns of technological changes. This curve provides nonsymmetry with the point of inflection that responds to the substitution process.

As have been considered above, all of the existing growth models are effective as the methodologies of time-series analysis for fitting historic data. These approaches mainly attempt to determine the steepness and shape of the curve and to model the time pattern of the technological change by using mathematical technique without consideration for major determinative factors or concepts for demand. These models have been still applied widely in various practical forecasting areas and enlarged their domains.

From above discussion, more formally, we can think of major factors determining the market demand discussed above as basic assumptions in our model as follows:

a) Consumers allocate their limited money income in order to purchase the basic subsistence quantities or minimum necessary quantities for a group of products first, and then allocate supernumerary to purchase its exceeding quantities and luxuries or high technology products in accordance with their criteria for expenditure.

b) The quantity demanded for a product depends on the level of money income and relative price of product under consideration.

c) The quantity demanded for a product depends on the level of stock, depreciation or its consumption.

d) The quantity demanded for a product depends on the preferences or tastes, which in turn depends on the necessity, usefulness, convenience, and technological competitive power of the product.

By introducing the assumptions above, the result of formulation of the model is given here in terms of a period analysis, since this is best adapted for actual application. The model, termed as approximate innovation diffusion model, can accommodate different patterns of technological substitution captured by the new technology. It allows the S-curve to be symmetrical and nonsymmetrical as well as asymptotic and nonasymptotic, with the point of inflection responding to the substitution process.

We formulate the basic demand (or purchase) function as follows:

$$Q_i = f(r_i, Y, P_i, S_i, T_i), \tag{1}$$

where Q_i is the demanded quantity for product i, r_i is the minimum necessary quantity of the product i, Y is the consumer's income, p_i is the market price of product i, S_i is the level of stocks for product i, and T_i is the level of preference or tastes of consumers for product i.

By using the artificial mean value of the rate of depreciation in existing stocks for the product, we can develop indirect measurement method, and calculate an approximate value. The formula for the rate equation of current purchases for potential purchases is written as

$$\begin{aligned}\frac{Q_t}{Q_p} &= a \cdot h \cdot y_{t-1} + h \cdot \frac{y_{t-1}}{k}(k - y_{t-1}) + \frac{h \cdot b_3}{1-a}\frac{y_t}{k}(k - y_t) \\ &+ \frac{\delta \cdot b_3}{1-a} \cdot \frac{y_t}{k}(k - y_t) \cdot j - \frac{h \cdot \delta}{1-a} \cdot \frac{y_t}{k}(k - y_t) \cdot 2j \\ &+ \frac{(c_1 + c_2 + c_4) \cdot h}{1-a} \cdot \frac{y_t}{k}(k - y_t),\end{aligned} \tag{2}$$

where Q_p is the level of potential quantities demanded of ultimate adopters at time t, S_t is the level of stocks at time t, k is an upper limit, a, h, δ, and b are the associated parameters of the model, $S_t / Q_p = y_t$.

The final formula for the rate equation of current stocks for potential purchases is approximately derived in a continuous form as

$$y_t = \frac{S_t}{Q_p} = \sum_{i=t}^{t-n+1} \frac{\Delta S_i}{Q_p}$$

$$= \frac{k}{1+e^{a_0 - \frac{h}{1-a}[t-(t-n)^+] + \frac{\delta(2h-b_3)}{2b_3(1-a)}[t^2-(t-n)^{+2}]}}, \qquad (3)$$

where $(t-n)^+ = \begin{cases} t-n, & \text{if } t-n>0 \\ 0, & \text{if } t-n\le 0 \end{cases}$.

The first coefficient of (3) represents the level of initial value for y_t, the second coefficient represents the positive influences by the changes of income, price, stock, depreciation or consumption, and tastes, and the third coefficient represents their negative influences by the another substitutes.

6. FORECASTING RESULTS

6.1. FORECASTING THE NUMBER OF B-ISDN POTENTIAL SUBSCRIBERS

The number of cumulative B-ISDN subscribers can be defined as the multiplication of the number of potential subscribers and the cumulative diffusion rate of B-ISDN services. Total number of B-ISDN subscribers includes all subscribers of both home use and business use. The number of households and the number of private enterprises should be used for a one unit of valid contract respectively so as to calculate the number of each potential subscribers with consideration of the scale of unit for practical subscription contract that could also possibly be used to figure out the number of valid subscribers of B-ISDN. We assumed that the number of households represents a population and the number of private enterprises represents the number of employed population with an average number of employers for each enterprise. In addition to those values, average contract rate should be added as a parameter for calculation. The result for long-run predictions of potential domestic telecommunication services subscribers is shown in Figure 5.

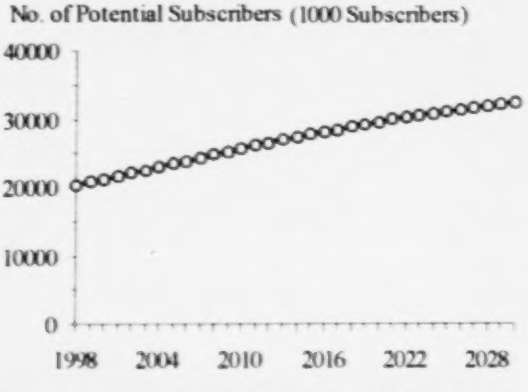


Figure 5. Long-run Predictions for the number of Potential Telecommunications Subscribers

6.2. DOMESTIC B-ISDN PENETRATION RATE

There should be a certain standard to measure the penetration rate of B-ISDN services in order to forecast how B-ISDN services could be reached to a certain level throughout the country. In this paper, the equation of penetration rate of B-ISDN has been derived by adopting the number of contracted subscribers as a standard that was initially used to figure out the number of potential subscribers. The equation can be stated as:

$$PB_t = \frac{BS_t}{PS_t} \times 100 = \frac{AS_t}{PH_t + PC_t} \times 100, \qquad (4)$$

where PB_t is B-ISDN penetration rate, BS_t is number of B-ISDN subscribers, PS_t is number of B-ISDN potential subscribers, AS_t is number of ATM subscribers, PH_t and PC_t are number of potential subscribers for home use and for business use, at t year, respectively. Also, the maximum value of B-ISDN penetration rate was figured out from the domestic telephone subscriber's penetration rate, under the assumption that current telephone subscribers would be changed to B-ISDN subscribers eventually. To derive out a regression equation of subscriber penetration rate, the data from 1978 to present has been utilized. By integrating these equations, we have derived the highest limit of a total telephone subscriber's penetration rate.

Table 2. B-ISDN Diffusion Scenario

Section	Description
Scenario 1	Growth rate of customer's satisfactions for B-ISDN services and products are equivalent to that of typical telecommunication services and products, and B-ISDN offers limited benefits in terms of convenience and cost effectiveness.
Scenario 2	Performances and functions of B-ISDN products are continuously improved, and B-ISDN offers great convenience as a result of the development of attractive applications, expended service areas and other factors, and running cost for B-ISDN, such as communications fees and rates, is acceptable to users.
Scenario 3	In addition to the benefits described in Scenario 2, customer's satisfaction is getting higher as a result of as the considerable reduction of the initial cost for B-ISDN, such as the price level for terminal equipment, as the network is further implemented. rapidly.

We have collected and utilized historic data of some typical products and services in electronics and telecommunications market such as telephone, stereo, facsimile, VTR, black and white TV, and color TV to illustrate the effectiveness and generality of the model. From those data, it is possible to take out an approximate trend equation by constituting a B-ISDN service diffusion scenario as shown in Table 2.

We forecast possible transition of ATM based B-ISDN diffusion rates on the basis of the statistical data on existing telecommunications products, services, and those of factors which affect diffusion rates. The results are shown in Fig 6.

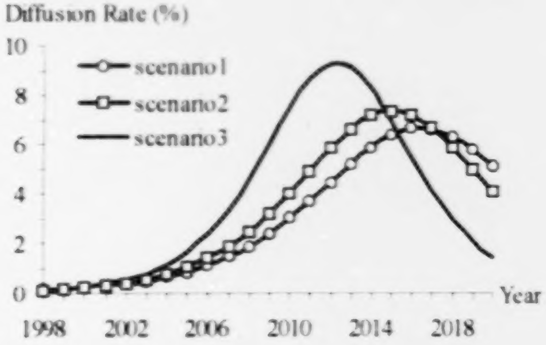


Figure 6. Transition Forecast for B-ISDN Diffusion Rate in Korea

6.3. FORECASTS ON ATM MARKET

One of the important tasks in providing B-ISDN services is the determination of the number of ATM switching system facility. For the installation of ATM switching system facility for B-ISDN services, many factors should be considered simultaneously such as extending scale for switching system, service capacity, level of demand for services, network planning, future demand forecast, and economical aspect of switching system facility extension. The most big difference between existing switching system and ATM switching system can be explained as their performance capacity and the amount of information required by subscribers among the factors mentioned above. Meanwhile, regional characteristics and economical aspect of switching system facility extension which can be categorized by external factors could be similar to that of existing pattern. Therefore, to derive the equation of demand forecast for ATM switching system facility, it is indispensable to consider those factors and it also needs an adjusting process to convert a derived ATM demand function to facility demand function as follows:

$$D_m^{[N_i]} = AS_i \cdot e_i = PS_i \cdot b_i \cdot e_i = PS_i \cdot b_i \cdot ex_i \cdot en_i \qquad (5)$$

where $D_m^{[N_i]}$ is new demand for ATM switching systems, e_i is adjusting coefficient of facility demand for ATM switching systems, ex_i is coefficient of exogenous parameter, en_i is coefficient of endogenous parameter.

The price of switching systems drops continuously as the prices of other high technology electronic communication products do. The characteristics of those high technology products at the introductory stage can often be described as high development cost, low demand, and absence of competitors. However, as time goes by, we have seen the trend that the price goes down rapidly by the enhancement of productivity, the rationalization of manufacturing technology, improvement of production technology, and challenge of competitors, which are due to increasing demand. Switching system may be divided by two parts; hardware and software. Depreciation in price of switching system mainly depends on the parts of hardware.

ATM switching system must be capable of handling a wide range of different bit rates and traffic parameters, as well as any functional requirements, in flexible and cost-effective ways. ATM switching system beginning at any level of functionality and service can also be built in accordance with a type of application of either public or private network and then added to, as needed, without expensive changes-outs or redesign. The possible scenarios for initial ATM price are shown as Table 3.

Table 3. Scenario on Price Falling Rate of ATM Switching Systems

	Description
Scenario 1	Initial price falling rate of ATM switching system would be similar to that of digital switching system
Scenario 2	Initial price falling rate of ATM switching system would be similar to that of computer and semi-conductor

Since the price of ATM switching system mainly depends on the processing capacity per each subscriber, there must be a certain standard. Therefore, we have used the price per port with 155Mbps data transfer capacity as a standard determinant price for ATM switching system. Currently, there are some switching system company trying to develop switching system for CPN, LAN, MAN, WAN that can be used in private network as well as in public network. Also, ATM trial switching system for public network has been sold for field trial. Here, we have not included the demand for substitution due to deterioration since we assumed that those values don't have important influence on the final results.

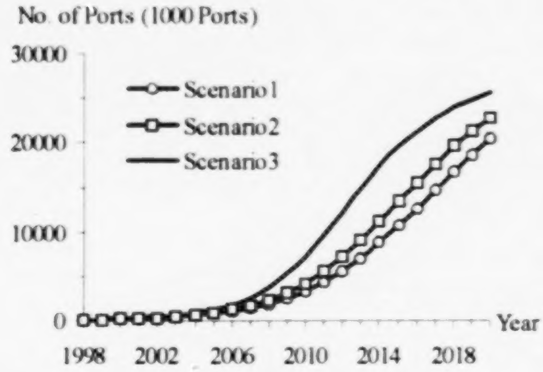


Figure 7. Forecast for ATM Services Market

By integrating the forecasting results for potential subscribers, B-ISDN penetration rate, and price per port of ATM switching systems, we forecast ATM services market in the favorable scenario. The results are shown in Fig 7.

7. CONCLUSION

Some of research institutes, manufacturers, and network operators, and academic circles of telecommunications fields are jointly working on the development of ATM switching systems as a major part of B-ISDN technologies. It will be accomplished in phase 3, resulting in the experimental ATM switching systems with a variety of functionality for provisions of various B-ISDN services to public users. Consequently, we expect that in the late nineties we would gain increasing momentum in the establishment of ATM based B-ISDN network. We also present the results of a case study on the forecast for ATM based B-ISDN penetration to analyze the transition process from existing switching systems to ATM systems. We develop a widely applicable diffusion model based on a conceptual framework characterizing several factors determining market demand for technological products. The model is developed partly in order to overcome certain limitations of existing growth models currently used for forecasting market demand for new products. Our model is developed by using relative weak assumptions commonly employed in the area of market demand and consumer behavior analyses in economic theory.

We have considered the main factors which have a great influence on ATM switching systems demand and domestic ATM market growth. We forecast possible transition of B-ISDN diffusion rates on the basis of analyses of the statistical data on existing telecommunications services and those of factors which affect diffusion rates. In the scenario, which is based on the most favorable factors for the spread of B-ISDN, the cumulative diffusion rate and ATM services market are expected to grow to 70% and 25 million subscribers by 2015. The presented results should be considered merely as one of the outcomes from the experimental applications and there should be studied with more specific attributes. Methodologies used in the paper may be applied as the framework for the forecast of growth of B-ISDN application system and also other various forecasting areas. Future research should be directed toward modeling the dynamic nature of consumers' behavior in the area of purchases, consumption, and etc. Also should be considered is the market condition of new technological products. Depending on the level of market competitions, pricing policies of producers should vary, and so does the effective demand given income level. Thus, the diffusion rate should be partly thought of as a function of the market condition.

References

1. F. M. Bass, A New Product Growth Model for Consumer Durables, *Management Science*, **15**, 215-27 (1969).
2. A. W. Blackman, Jr., A Mathematical Model for Trend Forecast, *Technological Forecasting and Social Change*, **3**, 441-5 (1972).
3. C. J. Easingwood, V. Mahajan, and E. Muller, A Nonsymmetric Responding Logistic Model for Technological Substitution, *Technological Forecasting and Social Change*, **20**, 199-213 (1981).
4. C. J. Easingwood, V. Mahajan, and E. Muller, A Nonuniform Influence Innovation Diffusion Model of New Product Acceptance, *Marketing Science*, **2**, 273-95 (1983).
5. J. C. Fisher, and R. H. Pry, A Simple Substitution Model of Technological Change, *Technological Forecasting and Social Change*, **3**, 75-88 (1971).
6. P. H. Franses, Gompertz Curves with Seasonality, *Technological Forecasting and Social Change*, **45**, 287-297 (1994).
7. H. S. Houthakker, and L. D. Taylor, *Consumer Demand in the United States*, Harvard University Press (1966).
8. S. H. Kim, *Development Plan of B-ISDN Technologies*, The Proceedings of the Korean Institute of Communication Sciences, Vol. 11, No. 12, pp. 38 - 46, 1995.

9. V. Mahajan, E. Muller, and F. M. Bass, New Product Diffusion Models in Marketing : A Review and Directions for Research, *Journal of Marketing*, **54**, 1-26 (1990).

10. E. Mansfield. Technological Change and the Rate of Imitation, *Econometrica*, **29**, 741-765 (1961).

11. R. Pearl, *The Biology of Population Growth*, Alfred A. Knopf, New York (1925).

12. M. N. Sharif, and M. N. Islam, The Weibull Distribution as a General Model for Forecasting Technological, *Technological Forecasting and Social Change*, **18**, 247-256 (1980).

A Control Scenario for Distribution Services in ATM Network

Moon-Kyun OH, Seung-Hee KIM, Jong-Tai LEE and Han-Kyoung KIM

ATM Multimedia Call Control Section, Electronics & Telecommunications Research Institute
161 Kajong-Dong Yusong-Gu, Taejon, 305-350, Korea

ABSTRACT

In asynchronous transfer mode (ATM) network, distribution services such as broadcasting and multicasting services require the point-to-multipoint connection. For the point-to-multipoint connection in ATM network, 'International Telecommunication Union Telecommunication Standardization Sector (ITU-T)' recommends its signalling capability in signalling capability set 2 (CS-2) step. So we survey the signalling capability and control procedures for the connection control, and propose a control method for distribution services in ATM network.

1. INTRODUCTION

Many people around the world have recently shown great interests in the high speed and wide bandwidth services such as conference communication, CATV and HDTV distribution services rather than telephone and low speed data communication. ATM communication technology was proposed to handle those services on equal base. ITU-T has also adopted the ATM as a basic transmission, switching and multiplexing technology.

Among the broadband ISDN (B-ISDN) services, the conversational services of the telephone and data communication require the establishment of point-to-point connection, but the distribution services[1] such as the broadcasting and multicasting do require the point-to-multipoint connection setup instead. The distribution services actually rely on the ATM cell replication function implemented on ATM switching board. For those services to be accommodated in the public ATM network, signalling protocols on user-network and node-node interfaces should be also developed.

The signalling capability Set 1(CS-1) of ITU-T contains the single point-to-point connection control and monolithic call and connection control, etc.[2] The already existing telephony and low speed data communication can be handled within CS-1 signalling capabilities, but the future B-ISDN multimedia and distribution services may require many new capabilities not treated in CS-1 scope, which are possibly the point-to-multipoint connection control, the multiconnection control, the separated control of call and connection, the connection modification, and third party control etc. Those signalling capabilities are currently under study in ITU-T SG11. All approved protocols have been distributed in the Q-series Recommendations.[3]

In this paper, we have studied control scenarios for distribution services in ATM network using the signalling messages in ITU-T Q-series recommendations. Our control concept is dynamic bandwidth allocation for the efficient usage of links between nodes, and we consider the efficient scheme of utilizing cell replication function at the nearest ATM switch to a destination party.

This paper consists of 5 chapters. Chapter 1 is introduction. In chapter 2, we survey the B-ISDN connection topology types for future B-ISDN services. Chapter 3 describes the control procedure of point-to-multipoint connection according to the recommended signalling protocol. In chapter 4, we propose a control method for the distribution service in ATM network, and draw conclusion in chapter 5.

2. CONNECTION TOPOLOGY TYPES IN B-ISDN NETWORK

The future multimedia services may request the establishments of various connection types in ATM network. ITU-T SG11 has classified the connection topology types(CTT) into 5 classes according to the number of communication partners (1:1 or 1:n) and communication direction (bidirection or unidirection), all of which are applicable to future B-ISDN services[3].

The first type of connection topology is the point-to-point connection. This one is appropriate for the conventional telecommunication services such as telephone, facsimile, etc. Communication direction may be unidirectional or bi-directional. Within CS-1, only this 'Type 1' single connection can be established per call.

The Second type has the unidirectional point-to-multipoint configuration. This 'Type 2' may supports multicasting and broadcasting services. In this type, we may introduce the term of 'root' and 'leaf'. The root is a source party sending user information to one or more sinks in unidirectional way, and the leaf is a sink party receiving information from the source. In type 2 connection, the broadcasting and multicasting services can be provided utilizing the cell replication function of the ATM switch.

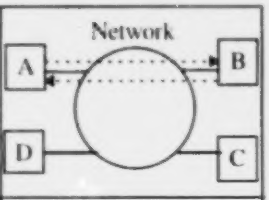
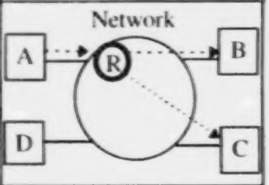
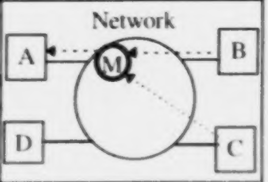
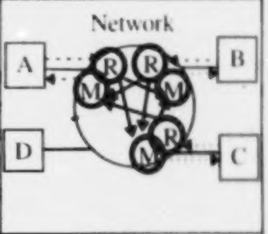
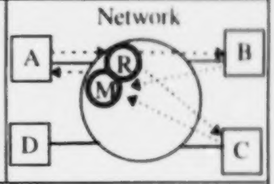
Type 1 : Point-to-Point Connection A unidirectional or bi-directional connection between two terminals.	
Type 2 : Point-to-Multipoint Connection A unidirectional connectio from a single source to tw or sinks.	
Type 3 : Multipoint-to-Point Connection A unidirectional connectio from two or more sources t a single source.	
Type 4 : Multipoint-to-Multipoint Connection A connection in which eac of the parties acts as bot sources and sinks so tha each is receiving an orderl combination of informatio sent by every other party.	
Type 5 : Bi-directional Point-to-Multipoint Connection	
A B C D : Terminals M : Merging Function R : Replication Function	

Figure 1. CONNECTION TOPOLOGY TYPES IN B-ISDN

For the multicasting service, the source, which provides the user information, should always be aware of all parties to which the connection travels. Therefore the root party has to explicitly tell the network certain leaf parties to be added or dropped from the call before and after the connection establishment.

But in the broadcasting service, however, the sink parties are not known to the source. The major difference from multicasting is that, for broadcasting service, the connection to individual leaf parties is not under the control of the root party, but controlled by the request of leaf party. Broadcasting service has not yet been seriously discussed at ITU-T and is, in fact, out of CS-2 range[3].

Third connection type, called 'Type 3', is based on unidirectional multipoint-to-point connection configuration. Televoting service may be supported on this connection type. For instance, people send their own opinions to a particular destination which just receives and processes them. For this connection type, ATM network is required of merging function. Merging function is not simple to be implemented as the replication function is, because processing layer should be higher than ATM layer.

Fourth connection type is multipoint-to-multipoint connection. This 'Type 4' could be used for teleconference services. The multimedia services based on this connection type is expected to be very popular in future.

The fifth type is the bi-directional point-to-multipoint connection configuration. To talk with many people on air, this connection type is required.

We summarize the classification of connection type in Figure 1. The connection types taken in CS-2 step are the connection type 1 and 2. ITU-T SG11 is developing the CS-2 signalling capabilities in the stepwise fashion, namely, step-1 and step-2. The CS-2 step-1 signalling capabilities are as follows.[4]

☐ Bandwidth modification
☐ Point-to-multipoint connection
☐ Point-to-point multiconnection control

Other control capabilities such as the third party control and 'look-ahead' functions are included in CS-2 step-2 signalling capability. However CS-2 signalling does not support the connection type 3, 4 and 5.[3,4]

3. THE CONTROL MESSAGE AND PROCEDURE FOR DISTRIBUTION SERVICES

3.1 MULTICASTING SERVICES

For the call and connection establishment of single connection or point-to-point multiconnection, ITU-T has recommended signalling messages and procedures via Recommendations of Q.2931. In the connection type 2, root requests establishment, release, addition and deletion of connection. Such messages and procedure are described in Recommendation Q.2971.[5]

The messages of ADD-PARTY, ADD-PARTY

ACKNOWLEDGE, DROP-PARTY, DROP-PARTY ACKNOWLEDGE are added up into the list of Q.2931 signalling messages. SETUP message in Q.2931 is now allowed to carry 'Endpoint Reference' information element. Other Q.2931 messages are almost same as before.

It can be easily determined from 'Broadband Bearer Capability' information element whether SETUP is for the point-to-multipoint connection or for the point-to-point connection. 'Broadband Bearer Capability' information element is supposed to have a field indicating connection type. After call and connection are established, for the any other leaf party, ADD PARTY message should be assigned the same call reference value used in the SETUP message and 'Endpoint Reference' field with nonzero value.[5]

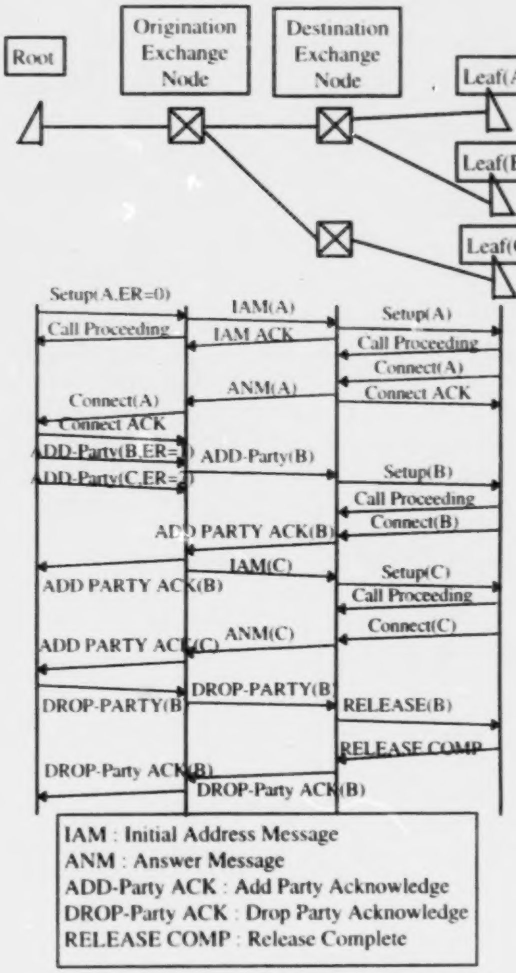

Root
Origination Exchange Node
Destination Exchange Node
Leaf(A)
Leaf(B)
Leaf(C)
Setup(A.ER=0)
IAM(A)
Setup(A)
Call Proceeding
IAM ACK
Call Proceeding
Connect(A)
ANM(A)
Connect ACK
Connect(A)
Connect ACK
ADD-Party(B,ER=1)
ADD-Party(B)
ADD-Party(C,ER=2)
Setup(B)
Call Proceeding
Connect(B)
ADD PARTY ACK(B)
IAM(C)
Setup(C)
ADD PARTY ACK(B)
Call Proceeding
Connect(C)
ANM(C)
ADD PARTY ACK(C)
DROP-PARTY(B)
DROP-PARTY(B)
RELEASE(B)
RELEASE COMP
DROP-Party ACK(B)
DROP-Party ACK(B)
IAM : Initial Address Message
ANM : Answer Message
ADD-Party ACK : Add Party Acknowledge
DROP-Party ACK : Drop Party Acknowledge
RELEASE COMP : Release Complete

Figure 2. THE CONTROL PROCEDURE OF MULTICASTING SERVICES

The control procedure for multicasting service is shown in Figure 2. Signalling messages used here has the same names of already known signalling messages. For the multicasting service, a root sends SETUP which is modified for point-to-multipoint call and connection. The purpose of sending SETUP by root is to request the setting up of user communication path in the network. On receiving SETUP, the network node processes the call and connection control procedure and transmits B-ISUP message to a destination node as a response to SETUP. The destination node transfers SETUP message to the first leaf party, and processes a related call and connection controls. After receiving CONNECT message, the switching nodes establish the user connection path and originating node relays CONNECT message to the root party. After the call and connection is established, the root party is now allowed to request party addition to network. At the destination node, SETUP is transferred to a leaf party in the response to the reception of ADD PARTY as in case of ADD-Party(B) in Figure 2. When the destination switching node receives CONNECT, it translates the message to ADD-PARTY ACK and transfers to the root party.

On the release phase, the root sends either DROP-PARTY or RELEASE to network. Receiving DROP-PARTY, switching node should check whether there is only one party to be dropped or more than one other parties still served. If only one is served and to be dropped, the node must send RELEASE to lower node as in the case of DROP-Party(B) in Figure 2. If more than one other parties are still served, the node must translate DROP-PARTY to RELEASE and send to lower node.

For the multicasting services, each node should keep the multicasting management table. Because, as mentioned above, on receiving the ADD-PARTY message from the upper node, the node also has to determine which of SETUP and ADD-PARTY should be sent to lower node. In the same fashion, receiving the DROP-PARTY message, the node decides to send a RELEASE or DROP-PARTY message to lower node.

3.2 BROADCASTING SERVICE

ITU-T has not recommended any signalling protocols for the broadcasting service yet. But broadcasting must be based on the point-to-multipoint connection configuration as described in Chapter 2. The broadcasting source does not care of the destinations. So connection setup request should be issued by destination users. The contents of this request message may not be the same as of SETUP message issued by root party for the multicasting service. So we like to give it a name of broadcasting request (BCAST_RQ) instead of SETUP for broadcasting service throughout this paper. The names for other signalling messages have are same as for multicasting services.

Even though it receives the BCAST_RQ message from a user (leaf), switching node can not act as a server or does not hold any information about which nodes can act as server for the requested broadcasting channel. In that case, it should ask for all concerned information to network management center. The flow sequence of broadcasting messages is depicted in Figure 3.

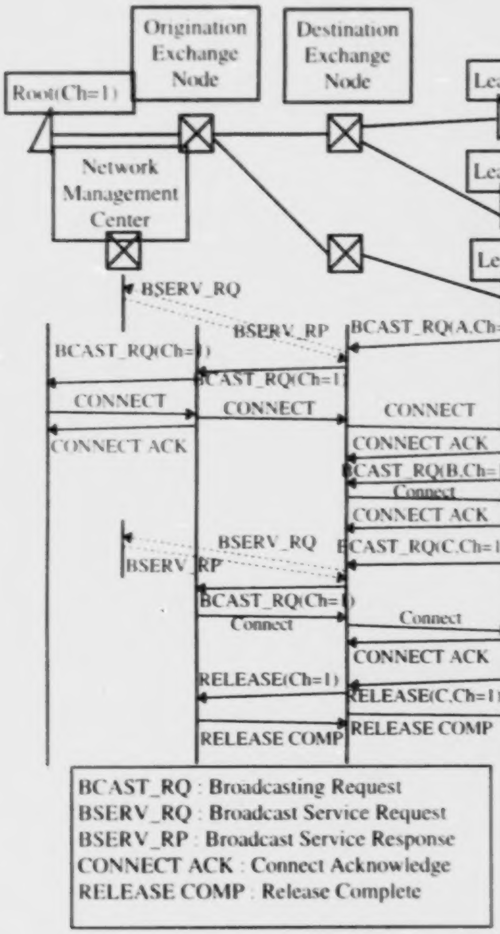

Origination Exchange Node
Destination Exchange Node
Root(Ch=1)
Leaf(A)
Leaf(B)
Leaf(C)
Network Management Center
BSERV_RQ
BSERV_RP
BCAST_RQ(A,Ch=1)
BCAST_RQ(Ch=1)
BCAST_RQ(Ch=1)
CONNECT
CONNECT
CONNECT
CONNECT ACK
CONNECT ACK
BCAST_RQ(B,Ch=1)
Connect
CONNECT ACK
BSERV_RQ
BCAST_RQ(C,Ch=1)
BSERV_RP
BCAST_RQ(Ch=1)
Connect
Connect
CONNECT ACK
RELEASE(Ch=1)
RELEASE(C,Ch=1)
RELEASE COMP
RELEASE COMP
BCAST_RQ : Broadcasting Request
BSERV_RQ : Broadcast Service Request
BSERV_RP : Broadcast Service Response
CONNECT ACK : Connect Acknowledge
RELEASE COMP : Release Complete

Figure 3. THE CONTROL PROCEDURE OF BROADCASTING SERVICES

Receiving the BCAST_RQ message from a leaf, any switching node checks a broadcasting service management table. If the broadcasting channel is already registered in the system, it will be easy enough to quickly set up internal path and instruct switch to replicate user cell for any user to be added. If not, the node should send broadcasting service request (BSERV_RQ) message to network management center, because the node does not know which of the nearest nodes could replicate broadcasting cells for the requesting user. Receiving a response message - broadcasting service response (BSERV_RP) - from network management center, the node send a BCAST_RQ message to the upper node and wait for CONNECT from upper node like BCAST_RQ(A) or BCAST_RQ(C) in Figure 3. Receiving CONNECT from upper node, it establishes a connection link of replication and transfers CONNECT to the user.

When RELEASE message is received from user, the node releases a internal switch path and deallocates output bandwidth and output virtual path identifier and virtual channel identifier (VPIo/VCIo) values for reuse. And the node sends RELEASE COMPLETE to the user and checks the broadcasting table in order to find any other route or links still in active state. If none, the node deallocates input bandwidth and input virtual path identifier and virtual channel identifier (VPIi/VCIi) then sends a RELEASE to the upper node as described in Figure 3.

4. A CONTROL METHODS FOR DISTRIBUTION SERVICE

4.1 THE CONTROL CONCEPTS

The B-ISDN would be operable on the basis of the ATM protocol. In ATM network, the point-to-multipoint connection may be established and released by the control procedure based on user-network interface (UNI) and node-node interface (NNI) signalling protocol. The entity to process the signalling protocol in ATM network may exist in the ATM switching system. Therefore it is, we think, important for us to study the point-to-multipoint connection control scheme also in ATM switching system, to fully support the multicasting and broadcasting service in ATM network.

In ATM network, signalling protocol and message for the point-to-multipoint connection have been recommended by ITU-T. So we propose a point-to-multipoint connection control method in ATM switching system, built upon the recommended signalling protocols.

The distribution services can be well described by a tree model. Bearing the model in mind, we can find the efficient method to make a use of link bandwidth and to utilize the cell copy function in ATM switching system. The followings are rules we rely on when we control connection links.

- ❑ Only one replicated cell flows on a link between switching nodes, considering on link bandwidth efficiency.

- One replicated cell flows into an ATM switching node.
- Dynamic bandwidth allocation scheme is adopted for inter-node link. That is, when there is no multicasting call in ATM network, there is no bandwidth allocation on inter-node link.

4.2 THE CONTROL METHOD FOR MULTICASTING SERVICE

On receiving any request related to multicasting service, the switching node determines whether the message is SETUP or ADD-PARTY. If it is SETUP, a call reference is assigned to the call. The switching node also allocates the input bandwidth and VPIi/VCIi internally to the multicasting source. Then the node finds a route and link to destination party and assigns output VPIo/VCIo and bandwidth.

A node transmits SETUP to the peer node. Because same control procedures described above are executed in the peer node, the peer node will respond to the originating node with indication of connection established. Receiving the response from the peer node, the originating switching node establishes point-to-multipoint connection, then sends acknowledge to the multicasting source in turn.

If it receives ADD-PARTY, the node has to check whether there is already existing call with the call reference appearing in ADD-PARTY. If it does, the switching node scans the multicasting service management table in order to retrieve service related information. The table keeps multicasting call reference, multicasting service count, destination position, etc. If the route or link to destination is not already active for the service, it is necessary to establish a new connection link to destination. The node assigns output VPIo/VCIo and bandwidth, and sends SETUP to the peer node. On receiving a response, the node sets up connection link via ATM switch. If the table indicates that the link to destination is already active, the node sends ADD-PARTY to lower switching node, and waits for a response. This control algorithm is depicted in Figure 4.

If it receives DROP-PARTY, the node should scan the multicasting table in the same manner as of receiving ADD-PARTY. If the related route or link serves no one except a party to be dropped, the node releases output bandwidth and VPIo/VCIo on the link, then transmits RELEASE to the lower node or destination. If the link still serves some other destination parties, the node decreases the counter only and sends DROP-PARTY to the peer

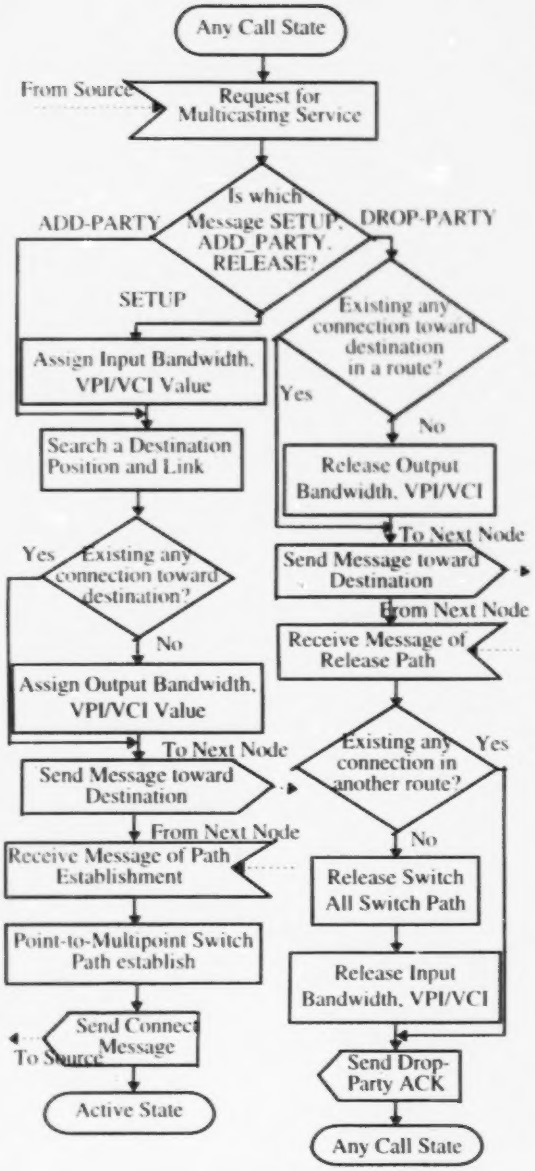

Any Call State
From Source
Request for Multicasting Service
Is which Message SETUP, ADD_PARTY, RELEASE?
ADD-PARTY
DROP-PARTY
SETUP
Assign Input Bandwidth, VPI/VCI Value
Search a Destination Position and Link
Yes
Existing any connection toward destination?
No
Assign Output Bandwidth, VPI/VCI Value
To Next Node
Send Message toward Destination
From Next Node
Receive Message of Path Establishment
Point-to-Multipoint Switch Path establish
Send Connect Message
To Source
Active State
Existing any connection toward destination in a route?
Yes
No
Release Output Bandwidth, VPI/VCI
To Next Node
Send Message toward Destination
From Next Node
Receive Message of Release Path
Existing any connection in another route?
Yes
No
Release Switch All Switch Path
Release Input Bandwidth, VPI/VCI
Send Drop-Party ACK
Any Call State

Figure 4. A CONTROL METHOD FOR MULTICASTING SERVICE

On receiving RELEASE, the node relays RELEASE message to all of peer nodes participated in the multicasting service, and also releases the whole internal multicasting switch path, input and output bandwidth and VPI/VCI for reuse.

4.3 THE CONTROL METHOD FOR BROADCASTING SERVICE

In broadcasting service, a subscriber can issue a request message for the connection establishment. On receiving the request, the switching node scans the broadcasting service management table. If the broadcasting channel requested is listed up on the table, the switching node assigns output bandwidth and VPIo/VCIo for the user and establishes a switch connection, then sends CONNECT to the subscriber.

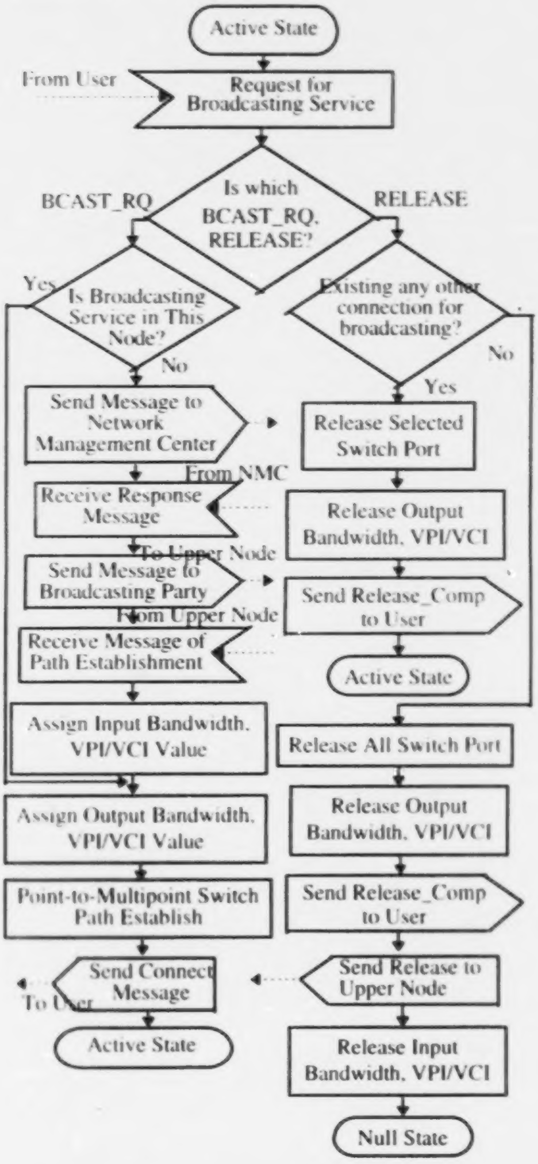

Active State
From User
Request for Broadcasting Service
Is which BCAST_RQ, RELEASE?
BCAST_RQ
RELEASE
Yes
Is Broadcasting Service in This Node?
No
Existing any other connection for broadcasting?
No
Yes
Send Message to Network Management Center
Release Selected Switch Port
From NMC
Receive Response Message
Release Output Bandwidth, VPI/VCI
To Upper Node
Send Message to Broadcasting Party
Send Release_Comp to User
From Upper Node
Receive Message of Path Establishment
Active State
Assign Input Bandwidth, VPI/VCI Value
Release All Switch Port
Assign Output Bandwidth, VPI/VCI Value
Release Output Bandwidth, VPI/VCI
Point-to-Multipoint Switch Path Establish
Send Release_Comp to User
Send Connect Message
To User
Send Release to Upper Node
Active State
Release Input Bandwidth, VPI/VCI
Null State

Figure 5. A CONTROL METHOD FOR BROADCASTING SERVICE

If it can not find the requested channel number in the table, the node sends a certain message to network management center specifying the broadcasting channel number in it, then waits for a response message which indicates the location of broadcasting source or the information for the connection route. Because the broadcasting cell flows only in the direction of source to destination, the node may send a connection request message to an upper switching node for receiving the broadcasting cell. The node assigns the output bandwidth and VPIo/VCIo on receiving CONNECT from the upper node, then sends CONNECT to the subscriber. The proposed control algorithm is shown in Figure 5.

A release request can be issued by user. However it does not mean the release of the whole broadcasting service itself but the drop of subscriber from the call. When it receives a release message, the node must scan the broadcasting table to determine whether the broadcasting service should be still maintained even after the user is released from the call. In other words, the node should check if some other users on different route or links are still being served. If true, the node releases only the corresponding connection link with RELEASE. But if no other subscriber are participated in the call, the node should release the whole internal point-to-multipoint connection. Then it frees the output bandwidth and VPIo/VCIo allocated for the user, and sends RELEASE COMPLETE to the lower node or to the user.

The node should also send RELEASE message to the upper node, because it is necessary to release a connection from upper node to current node in considering of the concept of control scenario proposed in this paper. The node deallocates input bandwidth and VPI/VCI value, and end the release processing.

5. CONCLUSION

We think that the B-ISDN will flourish on the basis of the ATM network with ATM protocol. To provide distribution services in ATM network, it is, we think, important for us to study the point-to-multipoint connection control scheme in ATM switching system also. In this paper, we proposed a control method and procedures for point-to-multipoint connection in ATM network. For distribution services based on the point-to-multipoint connection configuration, we discussed about the method of dynamic bandwidth allocation for the efficient usage of links between nodes, and considered the efficient scheme of utilizing cell replication function at the nearest ATM switch to a destination party.

Though we expect that the proposed control method and control scenario of the point-to-multipoint connection will improve system performance and make the implementation of point-to-multipoint connection control easy in ATM network, it will be still necessary to search for the more efficient schemes to control distribution services because signaling protocol is going to be more complex and hard to be dealt with in the simple mind and the characteristics of B-ISDN services are difficult to be analyzed precisely.

[References]

[1] ITU-T, "B-ISDN Service Aspects," *ITU-T Recommendation I.211*, White Book, 1991.

[2] ITU-T SG11, "B-ISDN DSS-2 UNI Layer 3 Specification for Basic Call/Connection Control," *Draft Recommendation Q.2931*, September 1994.

[3] ITU-T SG11, "Broadband Capability Set 2 Signalling Requirements," *Temporary Document*, TD PL/11-35C, December 1993.

[4] ITU-T SG11, "Generic Concepts for the Support of Multipoint and Multiconnection Calls," *Draft Recommendation Q.293x*, September 1994.

[5] ITU-T SG11, "B-ISDN DSS-2 UNI Layer 3 Specification for Point-to-Multipoint Call/Connection Control," *Draft Recommendation Q.2971*, September 1994.

A Study on the Service Node System for Future Telecommunication Services

Sun-Moo Kang, Bu-Ihl Kim, Young-So Cho, Byung-Nam Yoon
Switching Technology Division, Electronics and Telecommunications Research Institute
P.O.Box 106 Yusong Taejon 305-600, KOREA
etxkang@tdx.etri.re.kr

Abstract : This paper describes characteristics of coming B-ISDN services and classifies them. New trends on the service area causes changing on the service providing architecture and scheme. The most obvious differences are multimedia services and multiparty communication. It means the existing service providing scheme could not fully support this changing situation. Few years ago, multimedia service was not eligible to the public even though it is carrying much information at once, because of the shortage of transmission bandwidth. Nowadays, situation in the transmission area has been continuously changed. ATM technology is the most powerful driving force towards B-ISDN era. The essential components to constitute a telecommunication service is very hard to define, but conceptually, they are saying as transmission, terminal and switch. However, here we will define the fourth component to cover up the newly coming B-ISDN multimedia service, that is a service node system. We will define the function of this model and define interactions inside the model. At the same time, some scenarios are studied with this model.

1. Introduction

B-ISDN services are rather different from the existing services. Service area becomes wider and wider, from local to international, from single media to multimedia, and from point-to-point to multipoint-to-multipoint.

In the N-ISDN network, a fixed bit-rate channel is used and exchanged with circuit or packet mode switching for the existing voice and data services. However, the traditional services are almost based on voice, because of transport capability under narrow bandwidth and maintained by the one platform of switching system that can support only one service and one terminal type at a time. Therefore, in such a switching system, additional services added to itself holding a current system could not be properly implemented and depend on the particular networks. However, in the coming 21 century, ATM(Asynchronous Transfer Mode) will support a wide variety of broadband data, such as, voice, text, image with diverse bit-rates and will cover up all the type of services with different traffic characteristics. It is the only transfer mode used in B-ISDN. A lot of research work has been carried out on ATM switching technology since ATM was recognized as the most promising next generation network technology.[1] New service technology based on the future telecommunication network will be implemented on the basis of integration of ATM transmission technology, network and subscriber interfacing technology in the switching system, ultra high speed switching technology and signaling protocol.[2,3]

Services offered by a switching system are intelligent network service and multimedia data service that is a data communication service based on the computer networks. IN service has a few week points that are a long service implementation time from service definition to service implementation and network dependency of services limits the applicability of existing services to new network situation. Switching function should be changed or systems should be newly designed to fix this problem. It means that the existing service scheme is not flexible structure to cover up future service requirements.

We have defined a Service Node System(SNS) having three layered hierarchical protocol stack in order to accommodate various high quality services and the existing service effectively based on the broadband network. This paper introduces a functional architecture of SNS that includes Communication Control Function, Access Control Function, Service Control Function, Resource Control Function and Information Transport Function and interactions within the SNS.

This paper describes firstly trends of B-ISDN service development and its characteristics. We classify services on the SNS point of view, which is described in Chap. 2. Definition of a SNS architecture, and interaction protocols, application scenarios and interaction diagrams are defined and described in Chap. 3. Concluding remarks are added in Chap. 4.

2. B-ISDN Services and Classification

According to ITU-T standard specifications, B-ISDN services are classified with two categories. One is interactive services and the other is distribution services. Broadband services are termed multimedia services with audio, video, text and graph. It requires flexibility for the user, simplicity for the network operator, control of interworking situations and commonality of terminal and network components. For this purpose, independent call and connection control facilities are supported in the system.[10]

Multimedia services that can handle a combination of basic services as voice, video and data services simultaneously are already emerging in a world of separated telecom and data networks driven by the globalization of markets and the future telecommunication architecture need to support various services offered by several service providers and user's or terminal's mobility and multiparty service essential capability of network. We need common deployment architecture and execution of telecommunication software in order to support multimedia services based on ATM or advanced transport technique.

3. Service Node System (SNS)

3.1 Definition

We define a Service Node System, which has a 3 layered logical function blocks that consist of three layers, Information Transport Layer(ITL), Service Control Layer(SCL), Service Application Layer(SAL). The ITL is a transport layer based on the ATM protocol. The SCL is functioning to determine what types of connections are being requested and to direct the requests to the appropriate service provider function controller. It has also user authentication function to check the right of user accessing services. The SAL is a layer for the applications that can be executed on the Service Platform, on the help of underlying SCL and ITL layer. The ITL is based on the ATM transport layer[3] with broad bandwidth for multimedia services that satisfy high quality audio, and still and moving images. The SCL consists of SNS-DPE(Distributed Processing Environments) which is an infrastructure for distributed processing and the NCCE(Native Computing and Communication Environments). The SNS-DPE is pseudo operating system providing management, interaction of objects, interoperability, portability and reusability of applications. The functional structure of Service Platform in telecommunication network will support various services, terminal types, and terminal mobility to users. The SAL describes the Service Platform includes service objects for basic telecom services.

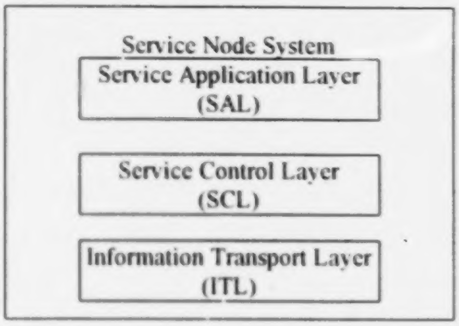

Service Node System
Service Application Layer (SAL)
Service Control Layer (SCL)
Information Transport Layer (ITL)

Fig 1. A hierarchical protocol stack of SNS

Fig 1 shows an entire hierarchical protocol stack of SNS. This can be modeled into two types, one type is centralized configuration and the other type is distributed configuration. The difference between them is follows. The centralized configuration of the SNS exists as a subsystem depending on the switching system under the main processor and the operating system. However, the distributed configuration is independent of the switching system and fully separated to it. Also it exists as a server on network that is just different structure of the switching system. Here, We borrow some concepts from TINA-C architecture concerning DPE and NCCE.[5]

3.2 Distributed Processing Environments

The SNS-DPE is an infrastructure that enables the deployment and execution of the Service Platform applications. Its architecture is to support design portability and interoperability of Service Platform applications. The DPE architecture describes common DPE services that are provided to the Service Platform application objects. These services are either functions to support the object interaction mechanisms, or functions that are deemed generic enough for being described as a part of the DPE architecture. This paper introduces the SNS-DPE services that are Trading Service, Notification Service, Transaction Service, Repository Service, Configuration Service, Security Service, Performance Monitoring Service.

Today's DPEs introduced already are OMG CORBA[4], TINA-C DPE[5]. We explain simply the TINA-C DPE services[5] as shown in Fig 2.

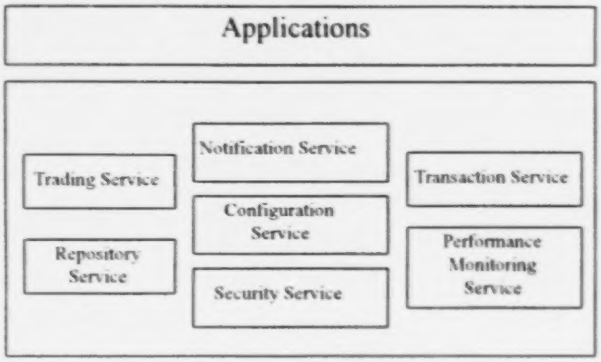

Applications
Trading Service
Repository Service
Notification Service
Configuration Service
Security Service
Transaction Service
Performance Monitoring Service

Fig 2. A Service of DPE

- Trading Service:The Trading Service supports late binding between Two objects, the exporter and importer. To do so, it administers information about service offers and their types, the associated interfaces, and QoS attributes. The exporter proffers its services(interfaces); the importer seeks services and employs the trading service in order to get hold of them.

- Notification Service:The Notification Service enables objects to emit or receive notifications without being aware of the set of objects with which it is communicating.

- Transaction Service:The transaction service provides transaction communication between objects with properties collectively referred to as ACID properties:atomicity, consistency, isolation and durability.

- Repository Service:The repository service provides persistent storage for the templates and guarantees unique identifiers for all the objects that it contains. The implementation repository service also provides storage for the installations and information related to the object implementations.

- Configuration Service:The configuration function holds and provides information about object configuration.

- Security Service:The security service provides functional support to security requirements of TINA applications(identification, authentication, authorization, etc.).

- Performance Monitoring Service:The performance monitoring service provides access and control over the performance of specific network resource activity in order to monitor the performance.

3.3 SNS Functional Model

The Service Platform includes service objects for basic telecom services. The functional structure of Service Platform consists of Communication Control function(CC), Access Control function(AC), Service Control function(SC) and Resource Control function (RC) as shown in Fig 3.

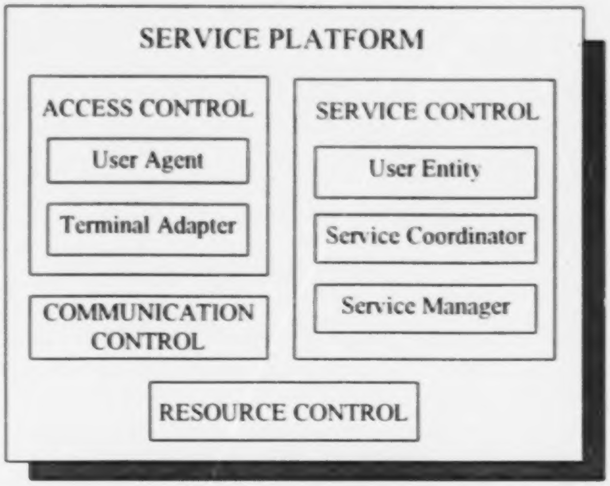

SERVICE PLATFORM
ACCESS CONTROL
User Agent
Terminal Adapter
COMMUNICATION CONTROL
SERVICE CONTROL
User Entity
Service Coordinator
Service Manager
RESOURCE CONTROL

Fig 3. Service Platform Functions

Fig 4. shows network configuration of SNS.

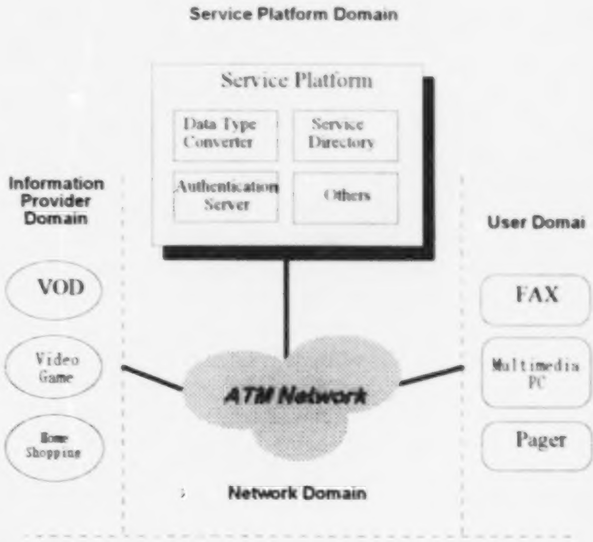

Service Platform Domain
Service Platform
Data Type Converter
Service Directory
Authentication Server
Others
Information Provider Domain
User Domai
VOD
Video Game
Home Shopping
ATM Network
FAX
Multimedia PC
Pager
Network Domain

Fig 4. Domains of a Service Node System

The CC is a part of function that provides point-to-point or point-to-multipoint to peer-to-peer and persists separation of call and connection. It consists of call control, connection control, service session control function.

B-ISDN signaling protocols should support end-to-end quality of service negotiation within and across networks, multimedia multipaty calls, in-call modifications to the call configuration and bearer capabilities, calls with one or more services invoked, user-to-user/service negotiation and heterogeneous calls and connections[6]. Thus to achieve most of the above mentioned functions it is required to separate call and connection control. Protocol standardization required for a new service should be kept separate from protocols required to control connections and other network resources. ITU-TS UNI and NNI signaling standards for managing broadband point-to-point switched connections have formulated in [7] and [8], while the ATM Forum has specified UNI signaling protocols for multipoint unidirectional and point-to-point bi-directional switched connections[9].

Connection control includes following functions.

- Establishing two party or multi-party call
- Adding or Dropping a conection or one or more parties to/from the established muntiparty call
- Synchronization among connections
- User creation service
- Service parameter negotiation during a call
- Analyzing terminal types
- Allowing or prohibiting of service addition, removal, changing in a call by a party

Service session control function controls the session between end users and service providers.

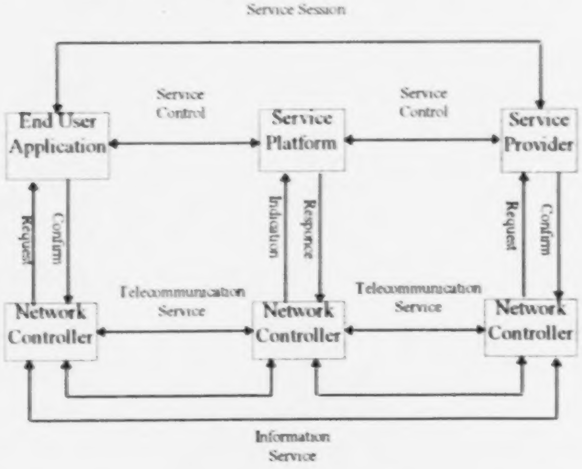


Fig 5. Session Control Configuration

The AC supports; a translation function that is in charge of translating the requests coming from a user terminal into service platform; and an access function that permits access to network, service platform, having user identification and authorization of the user for service; and a presentation function providing various formations of media.

- Terminal Adapter(TA):The TA handles the type of terminal the user is currently using. The TA acts as an adapter/converter between the presentation system used by user, for instance, it identifies whether user terminal type that will be access is only to support voice, text or document, or image or associated with them. It is the TA that drives the user application, performing tasks such as presenting windows and prompting the user on the user's terminal, and interprets the input from the user via SNS agent.

- User Agent(UA):The primary function of the UA identifies user's authentication, availability of service. First in order to authenticate the user, the UA contacts the Authentication Server. After that, the UA refer to user's information such as name and password from Authentication server. If authentication is successful, the UA continues; else it reports an authentication error to the user. The UA trades for an interface to the Service Profile Manager(SPM) in order to retrieve a list of the application service that is available to the user. The UA presents the list of services for the user and allows the user to select one. The UA calls another function in the interface of the SPM in order to start the selected service. First the SPM checks if the requesting user is authorized to use the service.

The SC supports three functions. First function is a user entity management function, which comprise only concerned with local user. Second function is a service coordination function that coordinates resources for supporting telecom service and user service. The third and last function are a service management function that manages each user entity and service related to them.

- User Entity(UE):Because the UE already has integrated information of user for service from UA and TA it is localized to user's requested service and does not relate any more with Access Control.

- Service Coordinator(SC):The SC associates the resources needing requested service and creates the service manager that combines UEs and resources.

- Service Manager(SM):The SM supports association of UEs and resource providing execution of service and sends the associated information of service to communication control.

The RC supports a resource management function that manages several resources for user services.

- Resource Manager(RM):The RM manages various resources for supporting service.

3.4 Interaction Protocol

We suggest a possible interaction protocol in the SNS. We defined functional components in the SNS. Each component is involved into providing services with doing its assigned functions in the protocol. Fig 6. shows the interactions among function blocks.

3.5. Application Scenarios and Interaction Diagrams

A multimedia on demand service scenario is very reasonable to consider as an on-coming B-ISDN service. Here we show a simple interaction diagram of the multimedia on demand service. That is a video on demand (VOD) service scenario.

VOD service consists of subscribers, VOD servers, transport network and a service platform to control connections and calls among users and service providers. Fig 7. shows an interaction diagram in the SNS for the VOD service.

4. Conclusions

This paper suggested an architecture of SNS for the future telecommunication service to accommodate coming B-ISDN services effectively based on a new service providing concept. Some scenarios and interaction protocols are presented to show the operating scheme of this system. Performance issues are considered to verify its usefulness and adequacy in the near future.

References

[1] Takeo Koinuma, Tatsuro Takahashi, "ATM Node System Technologies," *NTT Review*, Vol.6 No.1, pp.43-48, Jan., 1994.

[2] Jurgen Haag, "Network evolution with ATM. Implementation aspects in a Public Switched Telephone Network," *IEEE BSS 95*, pp.23-32, Poland, April 19th-21th, 1995.

[3] Rainer Handel, *ATM Networks : Concepts, Protocols, Applications*, Addision-Wesley, second edition, pp.55-139, Cambridge, 1994.

[4] Barry Kitson, "CORBA and TINA:The Architectural Relationships," *TINA 95 proceeding*, Vol. 2, pp.371-386, Australia, Feb. 13th-16th, 1995.

[5] Edward Kelly, "TINA-C DPE Architecture and Tools," *TINA 95 proceeding*, Vol. 1, pp.39-54, Australia, Feb. 13th-16th, 1995.

[6] Thomas F. La Porta, "An Experimental Signaling Architecture and Modular Signaling Protocols," *ISS'95*, Vol 2, pp.244-248, Berlin, April, 1995.

[7] ITU-T Recommendation Draft Q.2931, "Digital Subscriber Signaling System No.2," Dec., 1993.

[8] ITU-T Recommendation , "Broadband Integrated Service Digital Network User Part(BISUP)," Q.2761-2764, Feb., 1994.

[9] ATM Forum, "Signaling Specification Draft," Version 3.1, July 24, 1994.

[10] ITU-T recommendation I.211, ITU, Mar. 1993

<Addendum>

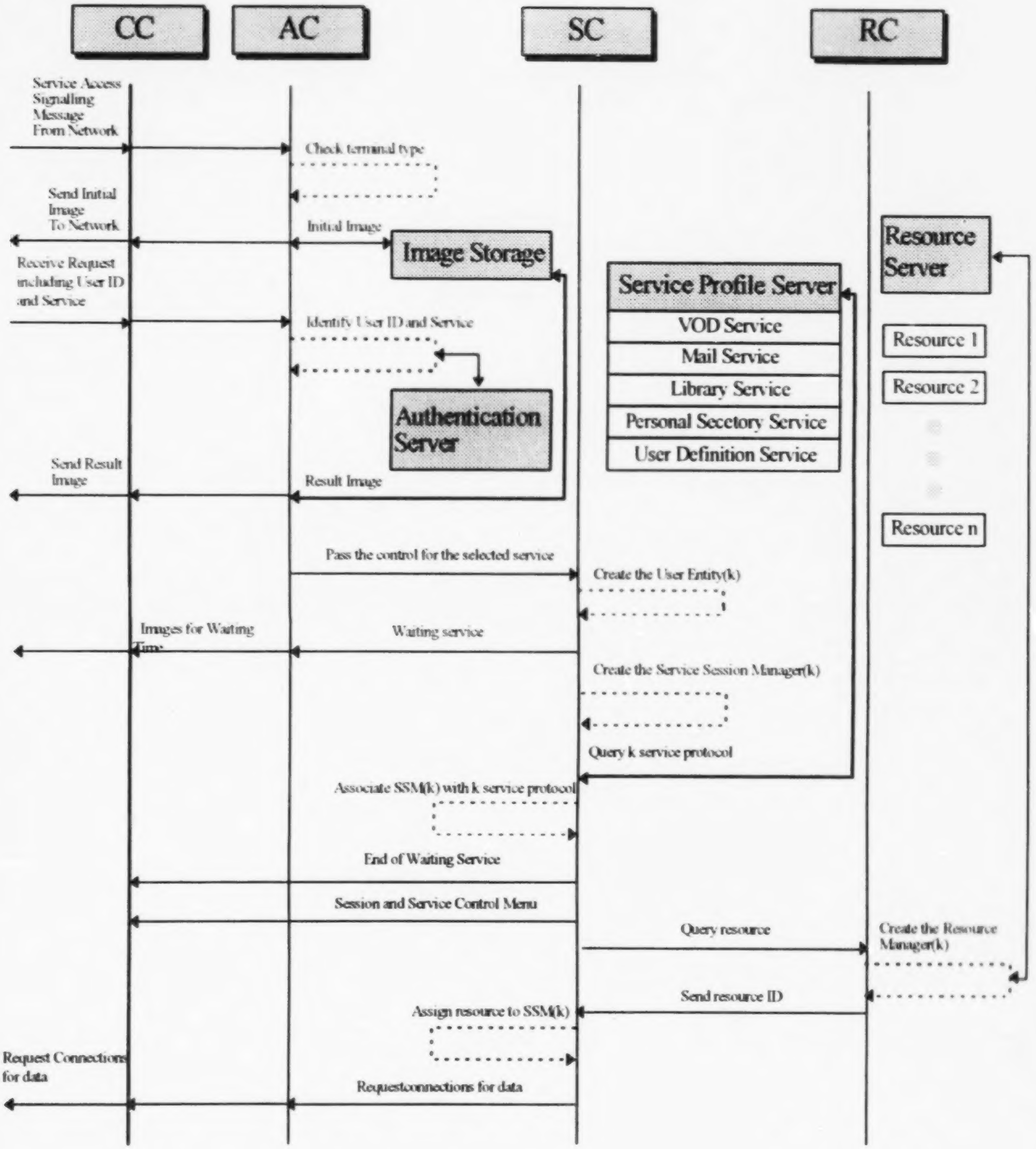

CC
AC
SC
RC
Service Access Signalling Message From Network
Check terminal type
Send Initial Image To Network
Initial Image
Image Storage
Receive Request including User ID and Service
Identify User ID and Service
Authentication Server
Send Result Image
Result Image
Service Profile Server
VOD Service
Mail Service
Library Service
Personal Secetory Service
User Definition Service
Resource Server
Resource 1
Resource 2
Resource n
Pass the control for the selected service
Create the User Entity(k)
Images for Waiting Time
Waiting service
Create the Service Session Manager(k)
Query k service protocol
Associate SSM(k) with k service protocol
End of Waiting Service
Session and Service Control Menu
Query resource
Create the Resource Manager(k)
Send resource ID
Assign resource to SSM(k)
Request Connections for data
Requestconnections for data

Fig 6. Interaction Diagram for a General Scenario

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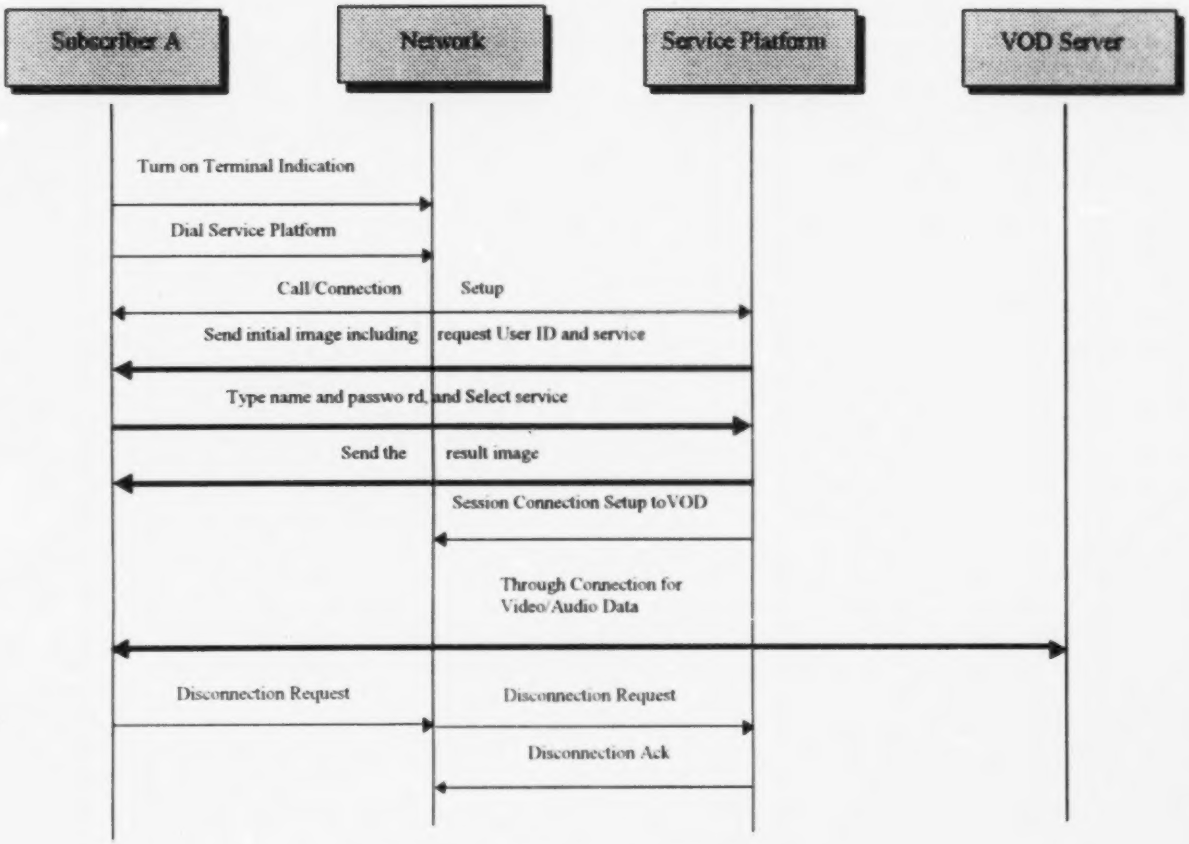

Subscriber A
Network
Service Platform
VOD Server
Turn on Terminal Indication
Dial Service Platform
Call/Connection Setup
Send initial image including request User ID and service
Type name and passwo rd, and Select service
Send the result image
Session Connection Setup to VOD
Through Connection for Video/Audio Data
Disconnection Request
Disconnection Request
Disconnection Ack

Fig 7. An Interaction Diagram for VOD service

Rules for an Interactive Road

MICHAEL REEDE

GILBERT & TOBIN, TECHNOLOGY LAWYERS

Sydney, Australia

1. THE NEW SERVICE ENVIRONMENT - PROPHESY OR MYTH

With converging technologies, it is also inevitable that the regulatory regimes which traditionally separately have governed telephony and broadcasting will converge. Telephony regulation has traditionally required third party access to telephone networks in a competitive environment, so that other network operators, and service providers which have no network of their own, can access a telephony network for the purposes of providing services in competition with the owner of the network. However, these concepts of access or interconnection have not formed part of broadcasting law, and broadcasters are not required to share their free to air spectrum or satellite beams to deliver the services of competitors.

Given the huge investments involved and the very different nature of the services being delivered, it may not be possible to apply this principle without qualification to broadband networks at least where there are alternative delivery platforms.

2. THE ATTRACTIVENESS OF AN OPEN ACCESS POLICY

The Australian Government established a Broadband Services Expert Group ("BSEG") to consider the evolution of broadband networks in Australia, and the Group has recently published its report called "Networking Australia's Future". The report strongly endorses the right of customers to have access to a full range of broadband services and the rights of competing service providers to have access to broadband networks in meeting those customer demands. The group stated:

> *The ability to communicate and the right to have access to information are fundamental to a democratic society. Access to digital information and the ability to communicate electronically may become just as fundamental in the future .... Access to broadband communications networks may become part of the basic community infrastructure - as essential as roads, electricity or water. The consultation process undertaken by the Group reinforced its belief in the importance of access and the affordability of new services.*

The group considered "the benefits of a broadband network will be maximised if non-discriminatory access is available to all services providers". The BSEG supported a regulatory framework that promoted choice, quality and affordability of content and services to the community by encouraging a vibrant, competitive communications industry in which both network-based carriers and service providers utilising capacity on carrier networks formed critical elements. The BSEG concluded that consumer benefit could only be maximised through a regulatory regime which promoted "open and equitable access" for users of services, service providers and broadband carriers".

The BSEG also thought that an open access regime would help mitigate concerns about uneconomic duplication of infrastructure. The Federal Government's Bureau of Transport & Communications Economics has estimated that it would cost over $40 billion to establish a ubiquitous broadband network in Australia, capital resources which are far beyond the ordinary financial capability of Australians. The BSEG was concerned that if competing broadband networks were being rolled out with the inevitable high level of overbuild, capital which could usefully have been deployed in building networks in other areas would be unnecessarily dissipated by a duplicated infrastructure. The BSEG commented as follows:

> *Duplication can bring with it consumer benefits from greater competition as well as costs. In any event, duplication will only occur in infrastructure if investors believe it will be profitable in the long term. A second infrastructure investor in a particular area will need to carefully assess demand, cash flows and the pricing response of the existing carrier before investing. Potential revenues from*

452

> *narrowband services such as telephony will be a major short term factor in determining profitability: nevertheless, it appears that the new entrants will be reluctant to undertake large scale duplication of infrastructure outside areas of high demand ....*
>
> *The incentive for unnecessary duplication of infrastructure will also depend on the degree of access that providers of services and potential infrastructure competitors have to existing broadband cable. In the longer term, open access arrangements are likely to reduce any incentive for unnecessary duplication by ensuring that a new entrant's decision is based, as far as possible, on demand factors rather than on an inability to gain access at a reasonable price to existing infrastructure. If access to broadband cable is available at a reasonable, commercially negotiated price, then there is likely to be an incentive to fully utilise the existing cable before building another. Of course, this price must represent a fair return on an investment if access arrangements are not to act as a break on infrastructure roll-out.*

3. APPROPRIATENESS OF OPEN ACCESS FOR BROADBAND NETWORKS

The principles of "open access" or "equal access" are well known within telephony regulation. Interconnection, of course, is an ever present issue when competition is introduced into the telephone industry. As its simplest level, interconnection ensures that customers connected to different networks are able to place calls between each other ("any to any interconnection"). However, interconnection and other regulatory obligations imposed on an incumbent carrier can be used as devices to ease market entry by new entrants, allowing those new entrants to avoid expensive duplication of infrastructure.

While the telephony world has by no means solved all of the thorny issues of interconnection, there is a developed body of learning about access and interconnection issues which could be transposed to a broadband environment. These access and interconnection models could be used to develop regulatory requirements for the provision by a broadband network operator of capacity on its network to service providers. This would allow those service providers to supply the range of interactive, entertainment and advanced communications services made possible by the broadband technology.

However, the carrier model developed for telephony networks cannot be slavishly applied to the very different world of broadband networks and to the distribution of entertainment and video-based services over those networks. Concepts such as "common carrier" imported from the United States are being used too loosely in the debate over broadband networks without a full regard as to how they are applied in the US to cable television networks and to the policy and economic consequences of applying them to broadband.

The supply of entertainment on broadband services is fundamentally different to the supply of telephone services. The "commodity" being sold to the customer on the telephone network is transport and connectivity for delivery of that customer's voice or data communication. The "commodity" which is made available by the network operator at the wholesale level to non-facilities based service providers is not that fundamentally different from the retail level product: that is, it is also a transport service. In the case of the retail service provided to the customer, the carriage is for the carriage of the customer's voice or data (the customer uses the carriage service to carry content supplied by the customer). At the wholesale level, the carrier providing interconnection services is providing a carriage service to the retail provider, which the retail provider then on-provides to the customer for carriage of the customer's content. The technical configuration of wholesale service provided at the interconnect level and the retail service provided to the end user are substantially similar: a switched voice channel.

The policy of open or equal access on a telephone network can be achieved in a way which preserves investment incentives primarily through a wholesale price which reflects the underlying investment. The network operator may not have captured the full retail value of the conveyance service provided to the customer, but through the wholesale price the network operator will have captured enough value to justify the investment. Hence, while carriers bear obligations of access to service providers under the *Telecommunications Act*, the price which they charge these non-facilities based providers is fundamentally a commercial price for transport.

In the case of a broadband service, the "commodity" being sold to the public is not the conveyance but it is the "content". Indeed, the method of conveyance may be a matter of little concern to the consumer. The customer will not much care whether the pay television signal is delivered by satellite, by MDS, by ADSL technology, or by broadband cable. Where there are competing delivery mechanisms which are available to a customer, the customer will focus on the content which is pumped down those systems in deciding which service to take. Thus, customers will choose between different broadband providers not on the basis of the delivery technology, but rather on the basis of the competing content which is delivered by that technology. (There is not, of course, perfect substitutability between all broadband delivery mechanisms to the home since only cable can effectively deliver interactivity. However, broadband radiocommunications technology is currently being rolled-out of the testing laboratories which will permit a wireless broadband solution which is substitutable for fibre optic/coaxial cable delivery. Further innovative delivery systems can also be expected.)

In a world where there are competing delivery mechanisms, it is therefore important for the network operator to have control over what is delivered to the customer through his or her television or computer. Unless the network operator "controls its own programming destiny", it will not be able to ensure that its product line up is more attractive to customers generally or to customers which that network operator has targeted than the services being provided by its competitors. Also, if there are competing delivery mechanisms, necessarily there needs to be service differentiation between those delivery mechanisms, otherwise there will be no competition between them.

An inevitable outcome of open access rules is the commonality of programming between different broadband systems. Content is "unhitched" from networks, and the same content can be provided by a service provider on more than one network. Accordingly, when a customer looks at the programming menus of the competing broadband network providers, there will be shared programming between the two, cancelling out service differentiation between them.

A common carrier policy could work against the dynamic of competing network delivery mechanisms. If a network operator had to provide capacity to "all comers", a network operator could not determine the nature of the service which was delivered to it customers. Further, there would also be a higher level of commonality in programming across all networks as the same service providers seek capacity on those networks.

Another important related consideration is that it is generally recognised that greater economic value lies in "content" and not "carriage". The importance of this is enhanced both because content is of such a premium given the vast amounts of content which are required to fully utilise broadband networks, and because, for the reasons outlined above, the end user product is conceived by customers in terms of content and not carriage. Further, the value of a particular service to the end user will vary depending upon the nature of the content. Customers will be prepared to pay much more for a hit movies channel than most customers will be prepared to pay for an art house cinema channel. A service provider may also be able to obtain higher subscription charges for a home shopping service than a specialist interactive information or educational service.

However, the underlying carriage service which is utilised to deliver these different types of content will often be technically equivalent or substantially similar. The carriage provider will be left in a position of charging a uniform price for carriage services which is low enough to make the less attractive downstream content services economically viable. This leaves the content provider to capture the lion's share of the higher margins available on the more profitable services.

Broadband networks involve huge investments. Optus Vision in Australia is planning to spend up to $4 billion on building a network to pass 3-4 million homes. Telstra/News Limited is proposing to spend a similar if not larger amount. Open access policies applied too rigorously would permit service providers who are not making similar large capital commitments to utilise the carrier's broadband networks to provide their content services. Given the dynamics outlined above, these service providers may be able to capture a substantial proportion of the economic value to be derived from services to be provided over broadband networks, leaving the carriers with an insufficient return derived from provision of carriage services to fund and justify their network investment. Further, the open access policy could decrease service differentiation between Optus' and Telstra's competing broadband networks, reducing competition which drives forward aggressive network deployment.

5. THE AUSTRALIAN SOLUTION

As noted above, the broadband networks in Australia are being built by joint ventures associated with Telstra and Optus respectively. As general carriers, Optus and Telstra are subject to substantial interconnection and access obligations under the Telecommunications Act. Each carrier must provide interconnection to the other carrier on a carrier-to-carrier basis. In addition, each carrier has obligations to connect the services of service providers (eg, resellers). These obligations are less stringent than the obligations which apply to carrier-to-carrier interconnection but are, nonetheless, significant.

Both Optus and Telstra were concerned about the full blown application of the Australian interconnection and access rules to the broadband networks which each of them are building, for the reasons set out above. Accordingly, they each adopted corporate structures which endeavoured to hold the broadband network in a corporate vehicle separate from the carrier entity. The result would have been that their respective broadband networks would be beyond the connection and access obligations of the *Telecommunications Act* which apply only to the main licensed carrier entity. These separate corporate vehicles would, for regulatory purposes, be service providers and not carriers, and as service providers would not be subject to any obligations to deal with other parties, except for Australia's general competition laws.

The Federal Government was alarmed about the implications which these "carrier associate" structures would have for the Government's open access policy, as framed in the BSEG Report. However, at the same time, the Government recognised the massive capital demands on Optus and Telstra respectively in relation to the construction of their networks, and the need to preserve carrier investment incentives.

The Government set about developing a new supplementary regulatory structure specifically applicable to broadband networks which would "strike the right balance between encouraging cable roll out and introducing broadband services in the long run". The Minister stated in a speech on 24 November 1994:

> *At first glance it may be appealing to simply require totally open access by extending the relevant sections of the Telecommunications Act to pay TV [and broadband networks generally]. This would, however, deny the builders of the cable a share of the revenues from content provision, as well as carriage, and the end result could be to delay the roll out of cable in Australia.*

The Government has come up with a hybrid model between traditional telephony regulation and broadcasting regulation. The Government proposes to issue this regulation as a class licence which will apply specifically to "carrier associate" service providers. The carrier associate is a service provider in which a carrier has a significant interest and which owns and operates a network which was installed and maintained utilising the powers of the carrier "parent".

The proposed class licence identifies three separate categories of broadband services, and applies differential access rules in relation to them. The three categories of services are:

- pay TV services, which include video-on-demand content. The definition of video-on-demand content is quite broad, and include not only movies but also serials, TV series (eg, Baywatch) and telemovies;

- point to multipoint services, which will include many of the broadband services such as video games, home shopping, etc;

- point to point services which includes telephony and the "true" interactive services which operate on the basis of individual access and interactivity between a customer and serving database.

The Government has granted a moratorium on access for pay television and VOD services until 1997. If the Government is satisfied at that stage that there is emerging competition between broadband networks, the Government will extend the moratorium until 1999. If the Government is not satisfied with the level of network infrastructure competition, the Government may refuse to extend the pay TV moratorium, at least in regard to the dominant network provider.

The purpose of the pay TV access moratorium is to permit the broadband network operators to fully utilise capacity for their own pay TV services. By being able to refuse access to other parties who would wish to provide pay TV services, the class licence ensures that all content revenue derived from these services on each carrier associate's broadband network is retained by that carrier associate. As the Explanatory Memorandum to the proposed direction states:

> *The exemption for "pay television" services recognises the need to provide appropriate incentives for investment in the initial stages of such services. The exemption has been designed to provide an incentive for the installation and rapid roll-out of cable, while giving a clear signal to the industry that the exemption from the general access regime is for a fixed period only.*

Once the pay TV moratorium expires, pay TV services will fall to be dealt with under the rules applying to point to multipoint or point to point services, as the case may be. Given the way pay TV services are defined, some pay TV services encompassed within the moratorium are point to multipoint - eg, traditional pay TV or near video on demand (NVOD) - and some are point to point - eg true video on demand.

The level, or stringency, of the access obligations varies between, on the one hand, point to multipoint services and non-carrier point to point services and, on the other hand, carrier provided point to point services. The obligations to interconnect in relation to the former categories of services are less onerous than the obligations in relation to the latter. This two tier structure is basically meant to reflect the differential obligations which carriers have under the *Telecommunications Act* in relation to carrier-to-service provider and carrier-to-carrier interconnection.

This two tier structure reflects the Government's intention that the carriers not be able, by establishing carrier associate structures, to avoid the core obligations under the *Telecommunications Act* in relation to PSTN and other telephony services delivered over broadband networks. As the Explanatory Memorandum states:

> *The Direction in no way replaces the obligations created by the [Telecommunications] Act. It should be noted that carrier to carrier interconnection of telephony services will be regulated under the relevant provisions of the Act (in particular Part 8 of the Act) which remain important to the Government's policy intention for the development of competition in telecommunications. Should any carrier seek to use any carrier affiliate structure to circumvent these provisions, the Government will seek legislative amendment to ensure this policy intention is achieved.*

However, the Government was less concerned to preserve the existing *Telecommunications Act* structure of interconnection in relation to point to multipoint services provided by a carrier. As these point to multipoint services will principally be in the nature of the "new" broadband services over and above traditional telephony, the Government did not see the same imperative to ensure that broadband networks owned and operated by a carrier associate should be subject to the same degree of interconnection obligations as they are for carrier provided point to multipoint services.

Non-carrier provided point to point and point to multipoint services continue to be subject to less onerous obligations of interconnection than carrier point to point services. This is because these services are also subject to less onerous interconnect obligations under the Telecommunications Act. Non-carriers are therefore no better off under the proposed class licence in respect of carrier associate networks than they are under the *Telecommunications Act* in respect of carrier networks.

The effect of "lumping" carrier provided point to multipoint services together with all non-carrier provided services (whether point to point or point to multipoint) is that the obligations of interconnection in relation to carrier services have been "lowered" from what they otherwise might be under the *Telecommunications Act*. The obligations now in respect of carrier provided point to multipoint services are made equivalent to the obligations which carriers have under the *Telecommunications Act* in respect of non-carrier provided services.

There are a number of grounds on which a carrier associate may decline to connect a non-carrier provided service or a carrier provided point to multipoint service, including:

- the service is not technically feasible;
- the carrier associate has reasonable grounds for believing that the person requesting access or the end user would not comply with the carrier associate's terms and conditions (eg, not credit worthy);
- the connection of the service facility would significantly reduce the capacity of the carrier associate's network to meet reasonably anticipated requirements of the carrier associate for use of its network, including for the introduction of new kinds of services; and
- the connection of the service would require the carrier associate to supply a particular telecommunications service that the carrier associate has not previously supplied to another person.

The first two grounds of "defence" to a request for interconnection are fairly standard. The second two involve considerations unique to broadband networks. In relation to capacity for future services, the problem with broadband networks is that the full suite of services which may eventually be made available on the networks has not yet been developed. The delivery technology is substantially in advance of the development of the "software".

However, there are, of course, services which currently could be provided on a broadband network. Both Telstra and Optus expressed concern that if they had an unqualified obligation to provide carriage wherever there was capacity, the broadband networks could be "filled up" with currently available services, reducing capacity for future innovation. Many of the currently available services are relatively "unintelligent" and do not exploit the full opportunities presented by broadband networks. There was the prospect of the broadband networks being overloaded with relatively "low grade" services, such as multiple home shopping services. The Government concluded that if the full potential of broadband networks was to be realised, it was important to ensure that there was "space reserved" for future services which are yet not developed or even not yet imagined.

There are, of course, opportunities for manipulation of this provision to "shut out" genuine competition in service provision. The Government has flagged that the regulator, AUSTEL, will monitor closely the carrier associate's use of this provision to refuse service connection.

The last "defence" (no requirement to supply a service unless already supplied to another) is intended to preclude mandatory unbundling of functionality. Broadband networks include a great deal of functional intelligence, not only in their switching but also in billing and customer interface systems. In addition, unlike traditional telephony, a broadband network also requires a deal of "intelligence" to be located at the customer premises' end of the network in the form of set top box or other similar equipment. This equipment communicates continuously with the network and activates or deactivates services and provides billing information etc.

Under the Telecommunications Act, a carrier can be subject to unbundling orders from the regulator, AUSTEL, requiring the carrier to split out and make available functionality within its network. Concern was expressed that if the unbundling rule was applied to broadband networks, it could have unintended consequences. One potential consequence could be a de-coupling of the set top box from the network and substitution or use of additional set top boxes on the customer premises. This "defence" allows the carrier associate to utilise its network in a "bundled" fashion if the carrier associate does not provide the network on an unbundled basis to any other party.

As stated in the Explanatory Memorandum:

> *It should also be noted that the "unbundling" provisions of the [Telecommunications] Act are not part of this access regime and are not intended to form part of any class licence. Carrier associates are to benefit from the economies of scale and scope involved in efficient vertical integration. Regulation of this aspect will be through the Trade Practices Act 1974 (Australia's general competition or anti-trust law).*

The obligation to connect a carrier provided point to point service more closely resembles the interconnection obligations between carriers under section 137 of the Telecommunications Act. The language of the Direction almost exactly replicates the language of that section of the Telecommunications Act. Basically, this imposes an obligation on the carrier associate to provide carriage services to the requesting carrier "so far as is necessary or desirable for the purposes of the requesting carrier supplying point to point telecommunications services".

The grounds on which a carrier associate can refuse to provide connection for a carrier provided point to point service are fairly limited, and basically centre on technical limitations within the carrier associate network. There is not, for example, the same right to refuse to connect carrier point to point services on the basis of reservation of capacity for future use, etc, as applies to carrier provided point to multipoint services or all non-carrier provided services.

Finally, the Direction deals with the concept of non-discrimination. It is a basic tenet of the Australian telephony regulatory regime that a carrier may not discriminate against a service provider (eg, a reseller) on the basis that the service provider is going to utilise the service provided by the carrier to compete against the carrier. The carrier is required to treat the service provider no worse than the carrier would treat a similarly situated customer. The requirement under section 183 of the *Telecommunications Act* is that a carrier must not:

> *"in relation to the supply of basic carriage services discriminate against a person for the reason, or for the reasons, including the reason, that the person:*
>
> *(a) supplies, or proposes to supply, eligible services under a class licence; or*
>
> *(b) wishes, or wishes to use, eligible services supplied under a class licence.*

Thus, protection is important to service providers which have no network of their own and are critically dependent upon the network of the carriers against whom they compete. Otherwise, a carrier could utilise leverage from its wholesale business, such as through pricing, to advantage its retail operation and limit competition from service providers.

However, the application of the non-discrimination principle in the broadband environment again runs up against the problems of "content" and "carriage" discussed above. As noted above, carriage services may be quite similar although used for content services which have very different retail values. A strict prohibition of non-discrimination would require the broadband network operator to price carriage services at the same level, regardless of the downstream value of the content carried using that carriage service. As the carriage service would have to be priced at a level which provides sufficient margin for the least expensive or least commercially attractive content service, the result would be that the prices for all similar carriage services would have to be set at that level. This would give large margins to service providers proving popular or expensive content using those same carriage services.

The Australian Government has provided in the class licence that a "defence" to the obligation of non-discrimination is a right to discriminate on the basis of the value of the downstream content service. The class licence will provide that the non-discrimination prohibition "does not apply in relation to discrimination by a carrier associate if that discrimination is justified by ... the commercial value to a person of services supplied or proposed to be supplied by that person using a telecommunications service supplied or proposed to be supplied by the carrier associate". The Explanatory Memorandum states in relation to this defence to discrimination:

> *[A carrier associate can discriminate on the basis of] the underlying technical characteristics of services provided by the carrier associate and ... the commercial value of the service provided by the service provider using the service obtained from the carrier associate. For example ... a carrier associate would be able to charge an eligible service supplier a different rate, depending on whether the service was used by the service provider for service with a high or low commercial value. For example, the telecommunications service used in a general home shopping service and foreign language entertainment service may have the same transport characteristics, but the services supplied to the customer may have a different commercial value.*

For example, the carrier associate may be able to charge a service provider $5 per subscriber for delivery of a French language movie channel but charge the same service provider or another service provider $10 per subscriber for delivery of an English language general entertainment channel and $15 per subscriber for delivery of an English language block buster movie channel.

By contrast, discrimination on this basis would not necessarily be permitted within the telephony regulatory regime in Australia. The retail price obtained by the service provider utilising the carrier provided wholesale services would be regarded as irrelevant to the setting of the wholesale price, at least where the retail price has no impact on the technical or other performance characteristics of the wholesale service or the volume in which the wholesale service is provided.

This "defence" permitting the downstream content value to be taken into account in pricing carriage reflects the approach taken in the United States which also allows cable network operators to take into account content value. Again, this is a major point of distinction between telephony interconnect and broadband interconnect as it would appear to be evolving in different jurisdictions.

6. CONFUSING CONTENT SUPPLY AND ACCESS

The debate about open or closed access sometimes confuses quite separate issues of diversity of supply and protections against undue leverage from vertical integration of network operation service provision and content production. An obligation not to provide "bare" transport services to another service provider does not translate to a network being a "closed network".

A network operator needs to obtain content which the network provider then distributes over its network to customers. Cable operators are large purchasers of content, indeed from time to time there are comments that there may not be sufficient content around to meet the capacity demands of broadband networks. Both Optus Vision and Telstra have said that their networks provide major opportunities for Australian content providers. Thus, just because the network operator is not a "common carrier" does not mean that it will be a "closed content" network.

There have been concerns about vertical integration of network operators into content supply, with the result that non-affiliated content suppliers are locked out of the content supplier market. However, this is not a question of access or interconnection in the traditional sense. The complaint is not that the non-affiliated program suppliers should be provided with transport services so that they can provide their services to customers. Rather, it is a traditional "anti trust" complaint that the network operators are not making rational decisions in acquiring programming which they resupplied to their subscribers.

The US *Cable Act* has introduced measures to provide greater opportunities for non-affiliated program suppliers. Section 11 of the 1992 *Cable Act* prohibits cable systems from programming more than 40% of their first 75 channels with their own programs (the programs that are supplied by commonly owned or controlled companies).

The participation of News Corporation in the Telstra venture and free to air television channels Seven and Nine in the Optus Vision venture will probably mean that there will be affiliated programming on both systems. However, it is unlikely that either News or the two television stations will be able to provide sufficient content to utilise more than a limited proportion of the capacity available on each system. In addition, subscription television broadcasting licences under the *Broadcasting Services Act* also carry a requirement of local content, which Minister Lee has said that he is likely to increase.

7. CONCLUSION

In conclusion, it is important that the social policy considerations, including access equity, be considered in relation to the advent of broadband networks. However, it is also important that investment incentives also be properly considered, otherwise the infrastructure for the future will not be put in place.

The principles of interconnection and access which have become accepted dogma in the telephony world may not be capable of application across the board to all services which can be delivered over broadband networks - or at least for an initial period of time during network roll out.

ELECTRONIC COMMERCE:
TECHNOLOGY OVERRULES LAW; THE $50 BILLION PIE

George E. Darby
Law Offices of George E. Darby
President, Teleport Asia

Abstract. Electronic commerce on the Internet is projected to reach $50 billion (US$ 50,000,000,000.00) by the year 2000 in one optimistic forecast, and only $5.8 million by the year 2000 in a different forecast. The range of forecasts reflects many factors, but the paramount determinants are probably the actual, and perceived, safety of financial transactions on the Internet. Sniffing, spoofing, and cracking, the terrors of the Internet, have stalled the growth of electronic commerce on the Internet and on other value added networks. The relative ease of sniffing (reading other people's electronic messages), spoofing (assuming a false identity and making fraudulent transactions), and cracking (stealing another party's confidential information stored on host computers), and the thefts that such techniques enable, have seriously impaired the growth of Internet-based commerce. The near term solution that will enable the growth of electronic commerce on the Internet is technological, and not legal, in nature.

Beyond the Web: Shopping Malls in the Living Room. Estimates of the annual sales volume of World Wide Web-based commerce in the year 2000 vary: $5.8 million (Volpe, Welty & Co.), $21.9 billion (Forrester Research), $50 billion (Hambricht & Quist). Without secure financial transactions over the Internet, however, these forecasts will all be thousands, or even millions, of times too optimistic. Ensuring secure financial transactions on the World Wide Web is singularly important to electronic commerce, since it will lead directly to the security of transactions over Interactive Television. Just as the commercialization of videoconferencing began with monochrome, still frame technology, and subsequently evolved to today's full motion, color videoconferencing based on Windows and ISDN, the commercialization of Interactive Television has begun as still frame graphics and multimedia files on the World Wide Web. The spectrum of video on demand, home shopping, business procurement, wholesaling, distance learning, and other Interactive Television services are much more akin to today's World Wide Web than to current cable television trials. The success of Interactive Television depends upon "anyone to anyone" connectivity, just as telephone service does. Users will not care what flavor of asynchronous transfer mode, encryption, or compression is used, so long as privacy and property rights are secure.

Fact moves faster than legal fiction. The law of property and privacy rights is ill prepared to deal with bandits on the Information Highway. Although the law of real property (legal interests in land and immovable improvements to land) and personal property (tangible, movable property) traces its roots to Ancient Greece and Rome, the law of intellectual property (rights to intangible products of cognition) began in Elizabethan England as a scheme of taxation. The Crown granted the right to publish (called a "copyright") in return for money. The sniffing, spoofing, and cracking that bring chaos to the Internet involve infringement of intellectual property and/or of privacy. Lawmakers, both legislative and judicial, have been struggling with revision of intellectual property and privacy law to bring order and commerce to cyberspace. The problem, however, is not so much the legal concepts that underlay traditional protection of intellectual property, but the lack of security mechanisms available to users of public data network, and more particularly, to users of the World Wide Web. In cyberspace, bank accounts are computer files. Court-based recovery, which is measured in years, of electronically diverted funds, which is accomplished in seconds, is unacceptable to merchants and banks. The first step in attracting commerce to the Internet lies not in hastily expanding the law of intellectual property, but in making the Internet as secure as, or more secure than, traditional commerce. That first step has two parts: message encryption, and user certification.

Acronyms of Security: S-HTTP, SSL, and MOSS. Terisa Systems, Inc., is the developer of the Secure HyperText Transfer Protocol (S-HTTP). Terisa Systems is 40% owned by Enterprise Technologies, Inc. (which invented S-HTTP) and 60% by IBM/Prodigy, Netscape, Inc., America OnLine, and Compuserve. Prodigy, America

OnLine, and Compuserve are direct competitors, as were Netscape and Enterprise Technologies before Terisa was formed. Netscape and Enterprise Technologies had developed rival World Wide Web security product; business indecision over adoption of one of the two standards threatened to split or delay the development of electronic commerce. Regular, that is, unsecure, HyperText Transfer Protocol ("HTTP") is the native message format, the lingua franca, of the World Wide Web. HTTP messages can be easily sniffed and spoofed, and HTTP host computers, called Web servers, can be cracked. S-HTTP encrypts individual World Wide Web applications, documents, or messages using public key/private key algorithms licensed from RSA Data Security, Inc.. The use of S-HTTP can be called "content encryption," in contrast to "conduit encryption" using Netscape's "Secure Sockets Layer" ("SSL") technology. SSL also uses RSA Data Security's public key/private key algorithms, but at the systems level to create a protected "data pipe". In a public key/private key system, messages encrypted with the user's private software encryption "key" can be decrypted only by that user's public key, which the user distributes or is available from a public site. Thus, the authenticity of a message having originated from a given user and having been unmodified can be established. The business alliance of Netscape and Terisa, and the participation of major value added network providers, will enable a single, secure transaction technology that uses both S-HTTP and SSL to be rapidly introduced and deployed on the Internet and on other value added networks. Encrypted messages stored on encrypted hosts and moved through encrypted pipes should open the floodgates to online marketing, payments, and general commerce on the World Wide Web, and subsequently on Interactive Television systems.

Importantly for international electronic commerce, the most secure version of RSA Data Security's public key/private key encryption technology is subject to U.S. Export Administration controls. The Export Administration has, however, granted export licenses for international use of certain, less powerful versions of such encryption technology. Some software vendors resent the central dependence of most encryption methods on RSA Data Security's algorithms. NetManage, Inc., a vendor of Internet software, and other software publishers are implementing the MIME Object Security Standard ("MOSS"), which uses non-RSA algorithms. MIME stands for Multipurpose Internet Mail Extension, a standard that enables the inclusion of many types of files, such as sound and video, within Internet mail messages.

Although the focus of the preceding discussion has been on the World Wide Web, the issues raised apply equally to proprietary networks, including EDI networks. Most, if not all, of these networks of necessity interface with the Internet. The proprietary networks may offer security for transactions solely within the proprietary portion of their networks, but a gateway to the Internet means that proprietary network users' messages that transit the Internet are as vulnerable to sniffing and spoofing as any other Internet message.

Secure conduits and content are necessary conduits, but not complete conditions, for the growth of electronic commerce. For electronic commerce to be more than "virtual private networks", bankers and financial institutions must adopt and support electronic commerce on a massive level. Adoption and support means, at a minimum, agreeing on a standard for "certification authority services." Fortunately, there is agreement, the X.509 standard; the current release of X.509 is Version 3.

How do I know you are who you say you are? Certification authority services provide a two-part background, "authentication" check as part of every financial transaction. Online certification services are actually more rigorous than traditional use of a credit card. At a fast-food counter or gas station, using a credit card involves a merchant's obtaining an "authorization code". An authorization code may be little more than a quick check against a locally hosted "negative card file," that is, a database that contains revoked or suspended credit card numbers (as distinct from a database of 'known good" card numbers). An information service provider refreshes a negative card file for a given customer every night, so the negative card file can be 24 hours out of date. A less risky (to a merchant) authorization process consults a centrally maintained "known good" card file, but the process of dialing the centrally maintained card file creates a longer delay in authorizing the transaction, which leads to longer waits in queues by customers. Even the "known good" card file may not confirm that the bankcard issuer has an credit card holder with the name used on the card; the confirmation is that the credit card number is valid (i.e., the number has been issued and the credit limit has not been exceeded).

Using certification authority services on the Internet, making a payment using a credit card is very similar to a wire transfer between banks: the consumer's name, card number, card expiration date, and available credit are validated; the merchant's name and merchant number are validated; and both the validation of the parties and the payment processing are encrypted during transmission.

The establishment of certification authority services will be performed independently by Visa and Mastercard. Given the sheer market presence of Visa (20,000 member banks, 400 million credit cards issued) and Mastercard (22,000 member banks, 277 million credit cards issued), this author believes that electronic commerce will begin in earnest in 1996, after the transaction standards and accompanying certification authority services are available. One recent survey of Internet users found that 80% of respondents were at least "somewhat likely" to make an online purchase if a credit card company was directly involved, but only 44% were at least "somewhat likely" if a credit card company was not directly involved.

Even the U.S. Postal Service ("USPS") plans to offer "public key repository" certification authority services by summer, 1996. The USPS' certification authority services are primarily intended to facilitate secure electronic mail and in summer, 1995, was undergoing widespread testing by the Federal Aviation Administration, Social Security, and the Internal Revenue Service. The USPS uses software from VeriSign, a company spun-off by RSA Data Security, Inc. An applicant for USPS "sender" certification status would present proof of identity, such as a driver's license, at a post office. The USPS would issue to the applicant a private key and a public key generated by the USPS and register (certify) the association of the applicant with the private key and the public key for a three year term. The "certified" sender would then use the USPS issued private key to encrypt the sender's signature or entire messages. Receivers of email from that sender could obtain the sender's public key to decrypt (authenticate) the signature and/or message.

Users of USPS services will be able to validate the authenticity of a sender by obtaining, for a fee, the sender's public key "code" or "certificate" from the USPS to decrypt the sender's signature, or entire email. Senders and receivers of email can also exchange public key certificates privately, but such bilateral exchanges become burdensome for merchants or if a sender changes its public key certificate. Tampering with USPS certified email will carry the same federal criminal penalties as tampering with tangible mail ("snail mail"). The USPS will also, for less than one dollar per transaction, time/date stamp email; the time/date stamp will be encrypted with the USPS private key, and decoded with the USPS public key. The time/date stamp technology, being developed by Premenos Corp. for USPS, should become as important, and even more reliable, in email legal documents than the manual dating of hard copy legal documents.

The Systems Picture. The two most important pieces of electronic commerce technology have been presented: message encryption, and user certification. Achieving a paradigm shift in financial payments systems requires application of those two technologies to the myriad of messaging relationships among consumers (both individuals and businesses), vendors/merchants, banks, "acquirers" (financial institutions responsible for real-time processing of payments, that is, depositing credits in merchants' bank accounts, invoicing consumers, collecting consumer payments of those invoices, settling payment disputes, and keeping a processing fee for doing the preceding tasks), and other intermediaries. User certification standards were in place by early 1995, but not encryption and overall systems for electronic commerce.

Flirtation with a Common Standard. For a period of several months during 1995, Visa International, Inc., and MasterCard International, Inc., agreed to develop and use a common, openly licensed, interoperable, platform-independent standard to provide secure transaction and payment processing services for the use of Visa and MasterCard credit card accounts over the Internet, wireless systems, and interactive television. Visa had been working with Microsoft in developing a version of Microsoft's Secure Transaction Technology ("STT"), and MasterCard had been working with Netscape in developing a version of Netscape's SSL. Microsoft's STT and Netscape's SSL technologies are not mutually exclusive: STT encrypts transaction data both at the endpoints and over the network; SSL encrypts data during transmission only. If used together, SSL simply "double-encrypts" SST messages during transmission over the network. The joint effort between Visa and MasterCard ended when MasterCard withdrew, alleging that the technology publicly disclosed would be inadequate to achieve the stated goals, and expressing dissatisfaction about Visa and Microsoft's decision to license, for a fee, certain necessary technology. The Visa/Microsoft standard is currently available, for a fee. The MasterCard/Netscape standard is scheduled to be available, for free, by January, 1996, and should be in use for secure transactions on the Web by April, 1996.

Exactly how consumer, merchant, bank, credit card association, acquirer, and other intermediaries' messaging systems for Internet commerce will be integrated with existing systems is not yet clear. In addition to the Visa/Microsoft and MasterCard/Netscape plans, VeriFone, Inc., the manufacturer of the most widely used credit card authorization terminals, has proposed an overall plan that uses VeriFone technology.

Shopping Agents. Once secure transactions technologies are established, the introduction of "shopping agent" technology should make electronic commerce even more attractive. Shopping agents are software applications that collect pricing and other data from vendors selling products over the Internet. Just as a user can now submit a search request to "search engine" on the Internet to retrieve relevant information, a user would submit a product model number or more general information to a shopping agent, which would visit electronic shopping malls around the world and return the results to the user. The user (or even the shopping agent) could then begin email negotiations over volume pricing, delivery, shipment method, etc., and/or use secure transaction technology to consummate the purchase. Shopping agents are already available from several publishers.

Conclusion. Electronic commerce on the Internet, World Wide Web, and other international value-added networks relies upon:

- encrypted content stored on encrypted hosts with firewalls (filtering of messages),
- moved through encrypted conduits,
- authenticated by a common certification authority service standard adopted by major financial institutions, and
- the integration of electronic commerce payments into an existing infrastructure based on credit cards and checks.

Among the many implications of the paradigm shift to electronic commerce is the broadening of electronic commerce to electronic banking. One study, published by Deloitte and Touche, predicts that the advent of such electronic banking in the U.S. will eliminate 450,000 bank jobs by the year 2000, and 50% of all bank branch offices by the year 2005. The near-term, rapid, national and international growth of electronic commerce on the World Wide Web, and subsequently on Interactive Television, may produce $50 billion in revenue, fewer bank jobs and branch offices, but it will definitely produce significantly more telecommunications jobs, revenues, and PTC papers.

Webography

Encrypting email:
http://draco.centerline.com/~franl/pgp/pgp.html

S-HTTP:
http://eitech.com/projects/s-http/shttp.txt

Electronic Commerce, MOSS, and S-MIME:
http://www.nwfusion.com
select "News+", then "Electronic Commerce"

Web Economy:
http://www.hamquist.com
http://www.forrester.com

THE LEGAL PROTECTION OF INFORMATION TECHNOLOGY IN KOREA

Kyung-Han SOHN
Attorney-at-Law
(Korea, Korea Patent, and New York Bars)

I. Introduction

1. Development of Information Industry in Korea

The Korean government has strongly encouraged the private sector to invest in and to develop information technology, especially in the hardware fields of the computer industry and the telecommunications industry. Reflecting this situation, for example, Samsung, the biggest conglomerate in Korea, lately has developed a 256M DRAM chip for the first time in the world, in the computer industry. Also, the Electronics and Telecommunications Research Institute of Korea has invented, independently, a CDMA technology, for uses in telephone communications to be developed in cooperation with Qualcomm Corporation.

Recently, the Korean government has begun to promote more strongly the software industry as well.

2. Recent Formation of the New Korean Ministry of Information and Communications

In order to establish comprehensive policies with respect to the information industry, and in order to set up and in an overall manner carry out programs relating to information and communication systematically and effectively at the governmental level, a new administrative ministry called the Ministry of Information and Communications (the "MIC") was created in late 1994. Until the formation of the MIC, regulatory authority regarding information and communications industries had been divided, amongst various different governmental agencies:

Software Industry - Ministry of Science and Technology
Hardware Industry - Ministry of Trade, Industry and Energy
Communications Industry - Ministry of Communications
Broadcasting (and CATV) - Ministry of Information

After the establishment of the MIC, the MIC submitted to the National Assembly a draft of legislation named the Information and Communication Promotion Basic Act (the "Basic Act"). The draft passed the Assembly and was enacted into law in July 1995, as a statute taking effect as of January 1, 1996. The Basic Act is directed to the promotion of informationization and of the establishment of the infrastructure of the domestic information and communications industry, which will result in the improvement of the quality of life and of the economic level of the citizenry. Although the Basic Act is somewhat abstract and proclamatory in its content, I believe that the Basic Act will be a vehicle for regulations and practices which will greatly contribute to the promotion of the information society in Korea.

3. Definition of Information Technology ("IT")

The term "IT" is one of the terms which has recently been used widely and increasingly in Korea. According to the Basic Act above, "Information" is defined as "all kinds of material and/or knowledge expressed as symbols, letters, voices, sounds, or images, etc., which are processed by a natural person or a juridical person through an optical (sensory), electric or electronic method, in order to accomplish a specific purpose." In addition, "Information and Communications" is also defined, as "a series of activities and means for promoting informationization of products, technologies, services, etc. in relation to the collection, processing, storage, checking, sending and receiving functions, and the utilization of said activities and means." Although the terms "Information" and "Information & Communications" are defined in the Basic Act, it is not easy to exactly understand the implications of the terminology of IT because of the intrinsically diverse aspects of the concept of IT itself.

I believe that it is a better approach toward an understanding of the terminology of IT if we consider the terminology of IT in connection with the "Information Industry." Generally, the term "Information Industry" is, in accordance with its literal meaning, usually discussed in Korea as one of the following concepts:

-Information Industry: Electric and electronics industry, the main subjects of which are directed to computer and software products.

-Information Processing Industry: Systems industry, where information is processed by way of computer.

-Information and Communications Industry: Industry reflecting the importance of industrial concepts promoted by way of electrical communications, which term covers the distribution of information as well through electronic methods and computerized methods.

-Information Technology Industry or Information and Communications Technology Industry: a new industrial concept, resulting from the phenomena of integration in the field of overall information technology, covering computer, software and/or other advanced communication technologies, etc.

-Information Network Industry: the industry wherein the electronic transmission of information is performed by way of networks.

Further, the term Information Industry may be considered to cover even the Mass Communications and Media Industry, that is, media industries in relation to communications and broadcasting, the press, publishing, advertisements, commercial videos and movies, etc.

Considering the above, I use the term "IT" in this presentation as indicating "technologies which are connected, in any form, with hardware and software relating to any kind of information."

II. Need to Protect IT

As the developments based on IT have proceeded rapidly, it has at first gradually and now ever more quickly become more difficult to regulate, under the existing legal systems, the various problems accompanying such developments. I shall now provide you with two examples, below.

1. Two Cases -- Examples Including Problems in Relation to "Call-Back Services" and "Music Provided by PC Networks"

The first example is that since 1992, in the fields of international telephone or fax services, more than 10 American companies have provided, in cooperation with Korean counterpart companies, services named "Call-Back Services" to the people in the Seoul area. Although the Korean government has construed that such Call-Back Services are in violation of the Korean Electricity and Communications Act and requested the companies in question not to provide such services, the number of such companies has since then sharply increased. The basic principles of such Call-Back Services are as follows: if a Korean person wishes to call someone in the U.S., the Korean person pushes buttons of specific numbers. With the cooperation between the Korean and American telephone service companies, a telephone signal from Korea is transmitted to a central source in the U.S. and on to the other person in the U.S. in a few seconds. However, the international telephone call is finally treated as a call made between the source and the person who are in the U.S., and not a call from a person in Korea to a person in the U.S. In view hereof, the charges for the Call-Back Services are charged on a second basis, and not on a minute basis like Korean telecommunications companies charge on, so that they are much cheaper than similar services as provided by the Korean telecommunications companies, in the range of around from 30% to 70%. The Korean telecommunications companies have urged the Korean government to regulate such companies providing Call-Back Services. Up until October of 1995, the Call-Back Services amounted to 3% of the total market share of the international telephone business. In this connection, the MIC together with Korea Telecom sent an official letter to the above-referenced counterpart companies in Korea, indicating that such services provided by the counterpart companies are illegal, and thus should be stopped. However, it is reported that only one of the counterpart companies responded by not providing Call-Back Services anymore and the other counterpart companies still provide such services. In a journal interview, an official who is in charge of such matters at the MIC made some comments on this matter, to the effect that although he thinks such services to be illegal, the ground of the illegality is not clear, and thus the Korean government is planning to promulgate concrete legal or regulatory provisions and will take concrete steps to handle such matters. He unofficially confessed that there is no substantive way technically or structurally to protect against the Call-Back Services, because those services are carried out in privacy.

The second example is an industry of music selections provided to consumers via PC networks. It is at present basically impossible for music disc companies to levy copyright royalties for use of the music distributed through PC networks, because there are at present no means or technologies to detect and no regulations to effectively protect against unauthorized acts of use of the type in question in Korea.

As clearly manifested in the above two examples, there is often no specific legal structure in Korea for handling and regulating new environments closely related with IT and/or other technologies, in spite of the degree of seriousness of the problems at issue.

2. Legal Protection Systems for IT Partially Established in the U.S. and the U.K.

In connection with the second example, a law for protecting intellectual properties embodied in digital form and distributed through computer networks has already been passed by both houses of Congress in the U.S. Also, in the United Kingdom, a famous media group and an entertainment group holding various copyrights has submitted to the competent ministry in the United Kingdom a proposal for the strong protection of intellectual properties in connection with digital data.

3. Direction of Development of Presentation

I will first discuss the conventional intellectual property (IP) legal regimes, such as the patent and copyright systems in Korea, available to protect IT. Thereafter, I will explain some non-IP regulatory regimes currently established in Korea to protect certain forms of IT. Then, I will discuss new approaches to protect IT, and the inappropriateness of protections under the existing traditional IP and regulatory statutes. After that, I will consider various approaches to provide more appropriate protection of IT. Finally, I will conclude this presentation by proposing my ideas on the formation of special committees at the national level as well as at the international level, for the protection of various different information technologies.

III. Current Legal Systems to Protect IT

A. Intellectual Property Protection

1. Protection under the Patent Act

a. General

The number of patent applications in Korea for inventions directly or indirectly applied to the information technologies, including, e.g., for the software necessary for operating computer equipment directed to various information technologies, has progressively increased over the scope of all technical fields related to IT, in order to keep abreast with the "information society." Therefore, under the Korean Patent Act (the "PA"), an information technology can be protected as an "apparatus invention" and/or "method invention" (process claim), if the invention meets the patentability requirements, i.e., novelty, inventive step, and industrial applicability.

In connection with IT, not only hardware-related inventions but also software-related inventions are broadly protected by patents, including, for example, Alphabetical-Letter Information Processing, Language Information Processing, Database Managing Systems (DBMS), and other many inventions regarding programming tools, and speech, image and character recognition, etc.

b. Registration Procedures

For obtaining a patent, the first-to-file rule applies in Korea -- the first person to file a patent application in Korea is generally entitled to registration even if he was not the first to invent the creation in question. Korea also has a system for the detailed and substantive "examination" of a patent application before registration. To this end, Korea adopts the "request for examination" system for substantive examinations.

Thus, patent applications do take quite some time to be procedurally examined and processed in Korea, but some interim protections are afforded to the applicant. For example, after laying-open of the application (the application should be laid open after 18 months from the filing date), the applicant can send a warning notice to those who have been working the invention or device. On publication of the application for public inspection and opposition purposes, the invention will be protected as if it were registered (so-called "temporary protection rights"). At that point, an applicant may exclusively work the invention and may demand compensation from anyone who has received a warning notice against working the invention.

c. Duration and Scope of Protection

The basic term of patent rights is generally 15 years from the date of publication of the application, but such term may not exceed 20 years from the date of the application. In connection with the patent term and other matters, Korea will have amended the current PA by the end of 1995 or at least early 1996, reflecting the GATT Uruguay Round TRIPs agreements. According to the draft bill to amend the PA, the term of patent rights generally shall now expire after twenty (20) years from the date on which an application was filed. In particular, an addendum to said new draft bill in respect of the PA provides that the patent rights which will exist at the time of the effective date of the amendment (July 1, 1996) will automatically enjoy an extension of patent term to the end of said 20 years.

d. Infringement, and Remedies Therefor

Any unauthorized working of patent rights constitutes an infringement of the registered holder's rights or, as the case may be, of any (exclusive) licensee's rights. Any unauthorized manufacturer, seller, commercial user, exporter or importer can be an infringer. The PA also provides for certain acts to be deemed to be infringement by constituting "contributory infringement". That is, if the patent or device is directed to a product, the acts of manufacturing, transferring, leasing, importing or displaying an article used solely for manufacturing the product as a business -- or if the patent is directed towards a process, the acts of manufacturing, transferring, leasing, importing or displaying a product used solely for working such process as a business -- constitute "contributory infringement" of a patent right. One recent development particularly worthy of mention is that a new draft bill in respect of the PA now before the National Assembly further provides an "Offer of Sale" as one of the activities deemed to constitute the working of an invention. Thus, if an alleged infringer would offer to sell someone articles infringing a patent, the fact of the offer of sale, itself, would constitute the infringement of the patent in question.

The PA provides, in detail, the relevant substance and procedures in respect of the remedies which are available against "infringement" activity. Under the PA, the remedies against infringement of patent rights include preliminary and/or permanent injunctive relief to cease the acts of infringement, an order of seizure or destruction of infringing goods, recovering damages suffered due to the infringement, and criminal sanctions. However, the TRO ("Temporary Restraining Order"), remedy is not available in Korea.

In a civil action in respect of patent infringement, a patent right holder, in principle, bears the burden of proof to show the existence and the likelihood of an infringement of the patent rights, by the alleged infringer. However, in such a case, it is generally accepted that it is usually very difficult for a patent or utility model right holder to prove the actual bad faith or negligence of the infringer. Considering the above, the PA provides for "constructive negligence", in that anyone who infringes a registered patent right or exclusive license right thereof shall be deemed to have been negligent in committing the infringement. Furthermore, there are two legal presumptions provided for, i.e., a presumption of damages and a presumption of a similar manufacturing process in relation to an allegedly infringing article similar to the patented one, in favor of the patent right holder, concerning the burden of proof. The presumption of damages is that the amount of profit earned by the infringer shall be presumed to be the actual damages sustained by the patent right holder or its exclusive licensee, unless a higher amount of damages is in fact proven.

e. Computer-Related Inventions

The Korea Industrial Property Office (the "KIPO") published rules entitled the "Standards of Examination for Computer-Related Inventions" (the "Standards") in November 1984, to establish a properly specialized and balanced level of examination for patent applications for computer-related inventions, separate from that under the Standards of Examination for General Inventions unrelated to computers.

Notwithstanding the existence of the Standards, which are applicable to both computer hardware-related and software-related inventions and provide global criteria for determining patentable subject matter and also provide disclosure requirements, the application of the Standards and in general the KIPO practices in connection with the examination of computer-related inventions in Korea are not well-determined or always consistent and thus, are still somewhat unclear or uncertain. Furthermore, as far as I know there has, to date, been no court case or decision on the patentability of a software-related invention in Korea (there has been some case precedent of the KIPO Trial Board and KIPO Appellate Trial Board on that topic, however).

In this connection, the KIPO established, in February 1995, new standards named the "Standards of Examination for Computer Software-Related Inventions." These new standards are mainly directed to inventions using software and have provisions dealing with patentable subject matter (including novelty and inventive step requirements) in connection with software which are more substantial and specific, compared with those provided in the 1984 Standards.

I believe that in the not too distant future there will be some court cases directly treating the issue of the patentability of software, due to both establishment of the above new 1995 standards and the impending establishment in Korea of a Patent Court, which is supposed to be established in 1998.

2. Protection under the Copyright Act

a. Protection of Works; Foreign Works

Protection of "works", a specially-defined subject matter of certain literary, artistic and other creative works (including those relating to IT) under the Copyright Act (the "CA"), is governed by a detailed regime set forth in the CA. Protection of works is normally achieved by way of copyright protections, which are a bundle of various rights, normally classified as the "moral rights" and "economic rights" of the author; some protections are also granted to performers, phonographic recording producers or broadcasters, print publishers, cinematic producers, etc., of works, by means of "neighboring rights" or similar rights.

The basic period of the duration of copyright protection of a work in terms of the author's economic rights is fifty (50) years after the author's death, as well as during his lifetime.

The work of a foreigner is protected in Korea in accordance with any relevant treaty or convention to which both Korea and the applicable foreign country are contracting parties, but only insofar as such works were first published abroad after such treaty or convention came into effect in Korea. At present, Korea is a party - effective as of October 1, 1987 - to the Universal Copyright Convention (the "UCC"), and to the Convention for Protection of Producers of Phonograms Against the Unauthorized Duplication of Their Phonograms ("Geneva Convention") and thus, any copyrighted works created and/or published before 1987 cannot be protected in Korea as proper copyrights under the current CA, which will be amended effective as of July 1, 1996; a draft bill of amendments to the CA was enacted by the National Assembly on November 17, 1995. Under the relevant amendments, copyrighted works created between 1957 and 1987 by foreigners will retroactively enjoy CA protection for the term of a fifty (50) year period commencing from the date of the work's creation.

Also, a work created by a foreigner may be entitled to protection in Korea on a domestic basis if (a) the work in question was created by a foreign individual having a habitual residence in Korea or by a foreign corporation having its principal place of business in Korea, or (b) it was published first in Korea, or it was published in Korea no later than 30 days from the date on which it was first published abroad.

b. Protection of Software (Computer Programs), under Computer Program Protection Act / Developments Peculiar to Korea

Three (3) possible approaches as to computer programs were discussed in the United States at the CONTU in the 1970s, and they are a copyright approach, a patent approach, and a *sui generis* approach.

In Korea, a sort of hybrid of the copyright approach and the *sui generis* approach was adopted in 1987. That is, in 1987, a special statute called the Computer Program Protection Act (the "CPPA") was enacted, apart from but based largely on the Copyright Act (the "CA"). The CPPA basically adopts the main principles of the Copyright Act in relation to the protection of software, but has some different principles from those of the Copyright Act in connection with certain matters, e.g., the computer program copyright administrative authority, the duration of a computer program copyright, etc.

Because the protection of works under the CA requires only creativity in light of literature, science or the arts and not industry, industrial applicability is not essential, but does not disqualify items as works. Computer programs are works and thus might simply have been protected by the CA; however, the authority governing computer program copyright matters was decided to be a different one from the one governing other copyright matters (the former matters had been governed by the Ministry of Science and Technology before formation of the MIC and now are governed by the MIC, and the latter matters are governed by the Ministry of Culture and Sports), and the CPPA came to be enacted separately from the CA and now governs computer program copyrights to the exclusion of the CA, with respect to the matters particularly covered in the CPPA. However, the provisions of the CA will apply as appropriate where there are no overlapping provisions in the CPPA which are peculiar to computer programs.

The same protections granted to the copyrights of foreigners under the CA are also granted to the computer program copyrights of foreigners, under the CPPA.

"Computer programs" include both source programs and object programs. Also, a derivative program is a protectable computer program (without prejudice to the protection afforded the original program). Certain items fall by statute outside the definition of a "computer program". It is not clear whether or how much the CPPA covers database, video games or ROM-BIOS.

The rights to a computer program are presently protected for fifty (50) years from the date of the program's creation.

Registration with the MIC will create a rebuttable presumption of the program's creation or first publication date. In practice there usually is a waiver by the MIC of the examination stage with respect to CPPA applications, so that applicants do not have to encounter difficulties arising out of a long examination period. Only upon registration will the right to assert against any third parties the validity of transfers, pledges and certain other restrictions as to the program come into effect. If a person works for an employer and creates the program in the due course of his employment, then the employer shall generally be deemed to be the author.

There is a special provision of the CPPA which promotes the circulation of computer programs. Namely, when a *bona fide* end-user requests the owner of program copyrights to supply the program for use by such end-user, and the program has already been released, the owner cannot refuse such request without just cause.

Under the CPPA, but not the CA, the negligence of an infringer is presumed (in the case of the infringement of registered program rights), and there is no provision in the CPPA (unlike the CA) allowing for a presumption as to the number of infringing reproductions which have been sold by an infringer.

Recent amendments to the CPPA effective July 1994 include the following. The amendments recognize the continued distribution rights of a user, if the program holder authorized the user to sell the original program or its reproduction. Notwithstanding this recognition, the amendments require the user to obtain specific consent from the program holder if the user desires to rent out the program for commercial purposes. Included as an act considered infringement under the amendments is the act of using a program for one's business knowing that the program is an infringing one. The amendments also substantially strengthened the criminal penalties for violation of the CPPA.

c. Protection of Database

Database is compactly-gathered mutually-related information for computer use for various purposes. Data projected within the base must be systematically deposited in a particular corresponding program. Suitable methods must be employed as to partially cancelling, correcting or examining the compacted data. Particular attention must be given to a situation where, intentionally or negligently, compiled data is changed, destroyed or infringed upon by someone in a position to do so.

Like some other new types of intellectual property, there is no specific statutory enactment in Korea for the protection of database as such. However, this does not necessarily mean that all database-related matters are excluded from protection in Korea. For example, Korean contract and tort law principles may apply to afford some remedies, although database itself is not recognized as a property allowing for the right to an injunction, with respect thereto, *per se*. Also, database is eligible for protection under the CA as a compilation, when there is creativity in terms of the collection and arrangement of the constituent data, but the difficulty with this is the CA may protect only database with said creative collection or arrangement of constituent data, and thus will not protect database having only creative search methods and no creativity in the collection and arrangement of the data itself. Under the CPPA a computer program to function with respect to the collection, search, etc. of data may be protected as such, but only to that extent; the data itself may not be protected. Also, under the PA, it is possible to obtain patent registration of a search mechanism, but this is not sufficient to protect the data thereby searched, as such.

Thus, in Korea there has been discussion with and among policymakers on whether to enact a special statute to unify and integrate, and perhaps expand upon, the database protections noted above, or, instead, to amend the CA, the CPPA or the PA so as to achieve the same said protective results but do so in one such existing statute. A final decision, whatever it may be, by the Korean government on these issues, and thus a legislative bill for consideration and for possible enactment by the National Assembly reflecting such decision, is not expected to be formulated very soon, however.

3. Protection of Trade Secrets and Know-how in Relation to IT

In addition to traditional protections of trade secrets and know-how based on tort or contract law, a more effective protection mechanism was introduced by way of amendments to the Unfair Competition Prevention Act (the "UCPA") in Korea, in 1992. The amendments were for the most part modeled after amendments to the 1990 UCPA of Japan, but unlike the Japanese and instead following the example of a German counterpart, had a provision for criminal sanctions. Trade secrets of a foreigner are protected even if the foreigner does not have a presence in Korea, if the foreigner is domiciled or has a business establishment in the territory of another nation which is also a member of the Paris Convention.

Under the UCPA, trade secrets are defined as technical or business information useful for business activities (for example, manufacturing know-how or management know-how) which (i) is not generally known, (ii) has independent economic value and (iii) has been kept or sought to be kept secret by reasonable efforts. Thus, trade secrets in relation to IT may be protected in Korea, if they meet some requirements discussed herein.

The violations of trade secret protection under the amendments are classified into six (6) different types: (1) Acquisition of Trade Secrets by illegal means, e.g., theft, fraud, embezzlement, duress or other dishonest methods, etc. (hereinafter "Illegal Acquisition"), or a use or disclosure by the acquiror of Trade Secrets thus acquired (including disclosure of the Trade Secrets to certain persons, while generally maintaining the confidentiality of it); (2) Acquisition of Trade Secrets, then actually known (or if not known, then not known due to gross negligence) that Illegal Acquisition was involved with respect thereto, or the use or disclosure thereof by such an acquiror; (3) Use or disclosure (after acquisition) of Trade Secrets, then actually known (or if not known, same due to gross negligence) that Illegal Acquisition was involved with respect thereto; (4) Use or disclosure of Trade Secrets by a person under a contractual obligation or an obligation similar thereto to keep the Trade Secrets confidential, for the purpose of obtaining unlawful profit or benefit or of causing damage to the owner of the Trade Secrets; (5) Acquisition of Trade Secrets, then actually known (or if not known, same due to gross negligence) that same were disclosed as described in Paragraph (4) or that such a disclosure was involved with respect thereto, or the use or disclosure thereof by such an acquiror; and (6) Use or disclosure (after acquisition) of Trade Secrets, then actually known (or if not known, same by gross negligence) that a disclosure described in Paragraph (4) was involved with respect thereto or otherwise that the Trade Secrets in question were the subject of such an improper disclosure.

Remedies can be (1) Injunctions/cease-and-desist orders; (2) Destruction of goods manufactured by the infringer, of equipment used for the infringement, or other necessary measures to prevent infringement; (3) Damages; and (4) Necessary measures to restore business reputation (if the infringer has purposely committed the infringement). However, a person who has acquired and used Trade Secrets prior to the effective date of the Trade Secrets protection amendments is allowed to continue to use, but is barred from disclosing, the Trade Secrets after the effective date thereof. A present officer (including a director) or an employee of a business enterprise who discloses to a third party Trade Secrets regarding production processes or other technology of such enterprise with a purpose of receiving unjustifiable benefit or causing injury to the business enterprise may be subject to criminal sanctions.

4. Protection of Semiconductor Integrated Circuit Layout Designs

On the computer hardware side, in relation to semiconductor chip integrated-circuit layout designs which are one of the major vehicles for the promotion and dissemination of IT, there is a new statute in Korea. For specific protection of such designs, the Semiconductor Integrated Circuit Layout Design Act ("LDA") came into effect on September 1, 1993. The LDA, however, does not apply to layout designs which were created prior to its effective date.

The subject matter to be protected by the LDA is a layout design in respect of a semiconductor integrated circuit. Only a layout design which is "creative" is protected under the LDA.

The layout design of a foreign national may also be protected in Korea under the LDA, or under any relevant treaties to which Korea has acceded. Provided, the Ministry of Trade and Industry has the right to order reciprocal treatment which is more restrictive than the provisions of the LDA or a treaty would otherwise allow, if the extent a layout design of a Korean national is protected in the relevant foreign country is not as great as the extent of protection of the rights of foreign nationals otherwise under the LDA or treaty.

A layout design right is created in Korea only by registration of it with the proper Korean authorities. A person who has a registered layout design has the right to exclusively use the layout design for business purposes, as well as the right to grant a license. However, the efficacy of a layout design right does not extend to 1) reproduction of the layout design for the purposes of education, research, analysis or evaluation or for a non-commercial use by an individual, or various reproductions for the purpose of the above; 2) a layout design which is made as a result of such research, analysis or evaluation and which is creative (so-called "reverse engineering"); or 3) the same layout design which is independently created by another person.

The duration of a registered layout design right expires ten (10) years from the date of the registration thereof. Provided, however, the duration cannot exceed ten years (10) from the date of the first commercial use of the layout design or fifteen (15) years from the date of its creation.

As for the infringement of a registered layout design right, preliminary and/or permanent injunctive relief as well as claims for damages are available under the LDA.

A compulsory license may be granted, in certain cases, to a person wishing to use a registered layout design after unsuccessful negotiations with the registrant, seeking a grant of a nonexclusive license. A registration of a certain layout design right may be cancelled before expiration thereof if certain requirements are met, e.g., if the registration was effected by fraud or other unlawful means, or if the registered layout design is not creative, etc.

B. Regulatory Protection

In some instances, IT is directly or indirectly protected by regulatory statutes, rather than by the IP statutes discussed above. The standardization policy of the Korean government has strongly influenced the level of protection of IT.

1. Disc and Video Act ("DVA")

The DVA is directed to a contribution to the people's cultural life, by enhancing the quality of discs and videos and by promoting sound development of the disc and video industry in Korea.

The DVA provides 1) that producers of discs and/or videos should be required to register them at the Ministry of Culture and Sports (the "MCS"); 2) for the cancellation of registration, if the registrant does not meet necessary requirements; 3) that if one wishes to import or to get the permission to copy discs and/or videos, the contents thereof should be examined by the Performances and Ethics Committee (the "PEC") of the MCS; and 4) that criminal penalties may be sought against anyone who violates the provisions of the DVA.

In particular, because a foreign citizen's or entity's discs and videos are legally able to be imported, sold or used only if there is the permission of the MCS, such permission under the DVA can be used as one additional means of protection in Korea for the copyrighted discs and videos of foreigners.

2. Film Act ("FA")

The FA is directed to a contribution to the national art, by promoting the development of the film industry, and by enhancing the quality of film art, in Korea.

The FA has specific provisions on 1) registration at the MCS of persons who produce films or import foreign films for business purposes ("film producers"); 2) disqualification requirements in respect of film producers; 3) cancellation of registration, if a registrant does not meet necessary requirements; 4) control of production and importation numbers in respect of films, per year; 5) recommendations of exports and imports of films; 6) examination of films by the PEC before performances, and related examination standards; 7) the establishment of the Film Promotion Public Corporation; and 8) criminal penalties.

Under the FA, if a person desires to import the original negative of a foreign film and to make duplicate prints, or to cinematize a foreign copyrighted work, he shall obtain the permission of the MCS, by submitting a copy of the import contract he has entered into with the owner of the original negative or an agent, or a copy of the consent of the original author. In this way, copyrighted films of foreigners can be protected under the FA.

3. Computer Networks and Networking Promotion Act ("CNNPA")

The CNNPA regulates basic items concerning the supply and the extension of computer networks, and the utilization and promotion thereof.

The CNNPA requires the MIC to be in charge of 1) establishment of a basic plan for the development, supply, utilization, etc. of computer networks; 2) establishment and operation of a Mediation Council of Computer Networks; 3) establishment of a National Computerization Agency; and 4) development and promotion nationally of basic computer networks. The MIC in connection herewith is to systematically and comprehensively administer IT and related information. The MIC may establish technology standards in order to achieve the compatibility and connectability of computer network-related technology and facilities. Manufacturers and importers of network-related equipment are required to obtain approval for their models from the MIC.

Persons who interfere with or damage network security systems or who disclose secrets which are processed, stored or transmitted by way of networks shall be criminally punished. In this way, therefore, network security systems and secret information are protected under the CNNPA.

4. Information and Communication Promotion Basic Act

As already discussed in the introductory part of this presentation, the Basic Act is directed to establishment of the infrastructure of information and communications, and to the continuing improvement thereof.

The purposes of the Basic Act are the 1) promotion of informationization; 2) establishment of the infrastructure of the information and communications industry; 3) improvement of the infrastructure of information and communications; and 4) due procurement of funds for promoting informationization.

According to the Basic Act, in order to develop technologies and to enhance the technical level necessary for establishment of the infrastructure of the information and communications industry, the Korean government shall emphasize certain items, covering items such as research of technology levels, R & D of technology, an estimate of the value of utilization of developed technology, technology cooperation, technology instruction, and technology transfer, and also items such as the smooth circulation of technology and information, and other items. Thus, I believe that foreigners who may wish to engage in Korea in business in the information and communications industry can receive important protections, especially in relation to an estimate of the value of utilization of developed technology, and to technology transfer, under the Basic Act.

5. Radiowave Act ("RA")

The RA is directed to the effective utilization and control of radiowaves, and the promotion thereof.

The main contents of the RA deal with the 1) licensing, operations, reviews, and controls in respect of radiowave stations; 2) imposition and levy of certain utilization fees, in respect of radiowaves; 3) establishment of basic plans for the promotion of radiowave technology; and 4) establishment of business groups for managing the radiowave stations.

6. Software Development Promotion Act ("SDPA")

The SDPA is directed to the creation and promotion of software, and to the wide utilization thereof in the economic, social and public fields in Korea, and thereby to the enhancement of the people's standard of living and sound economic development.

The main purposes of the SDPA are the 1) establishment of a Council for the Promotion of Software; 2) performance and promotion of business necessary for developing software and the systems thereof, through any qualified and competent authorities, e.g., colleges or research institutes, etc.; 3) control and distribution of information relating to software in order to prohibit double investment; and 4) establishment of basic plans for promotion of the development of software technology and the software industry.

IV. New Approaches to the Protection of IT

A. Need for New Approaches

1. Peculiarity of IT

In addition to the examples discussed above, the need to protect IT in new ways is basically required, from the intrinsic aspects of IT itself, in accordance with the rapid development thereof. I will first discuss certain characteristics of the IT environment, which are classified into the following four specific aspects.

a. Digitalization

As is well known, IT is basically based on the development of computer technology using the digital method. All information in the digital method is represented by the combination of two digits, such as 0 and 1. Such digital method is characterized in that a massive amount of information may be highly compressed, and may also be easily and freely stored, checked, retrieved, changed, and edited.

The merits of digital technology are that it can sharply increase the capability of representing information, through the digital method, and further promote the free communication of information. Digitalization gives users an easy way to approach new information, which results in expansion of the common areas of information and thus makes rapid progress in relation to mutual communications amongst individuals.

b. Globalization

As IT has developed abreast with the development mainly of single tangible media, such as discs or CD-ROMs, etc., a large degree of information is able to be transmitted to the public and individual persons and the transmission and receipt of information in an interactive way is also possible, in accordance with the progressive development of information and communications networks using the infrastructure of the information superhighway. In particular, open networks such as the Internet, etc. are widely used, while freely crossing over national borders.

Globalization can also be made rapidly if an optical cable network system is structured and thus, the world is connected with lines of an optical cable. In such a case, all the people of the world could share commonly the same information and utilize the information freely under the same conditions. It is desirable for the provider of information, because the information provided by the provider can be widely used.

c. Personalization

It is possible for individual persons to approach a huge amount of information through personal computers connected with back-up data without using any other form of media (simultaneously with the fact that information is created easily by individual persons via PC), due to the achievement of high quality and low prices in the personal computer field, and to the increase of communication using personal computers.

Such rapid distribution of personal computers and development of communication makes it hard to control the use of copyrighted works. As a result, the copying of copyrighted works is possibly made by individual persons in the private domain, e.g., at home, through personal computers, while in the past it has been performed by only limited and specific infringing experts.

d. Standardization

In order for networks to function smoothly, one of the most important requisites is that any of the users can access necessary information under the same conditions. Another important requisite is to secure mutual operability amongst the networks, units, software, and services which structure the infrastructure of information. That is why a standardization of technologies in relation to the infrastructure of information is required. In reality, creative copyrighted activity is now largely made based on the standards of substantially standardized technologies, such as UNIX machines, and TCY/IP and Windows, which are standard interfaces of the Internet.

2. Inappropriateness of Intellectual Property Protection

Based on the four characteristics of IT discussed above, technologies concerning information and communication can provide us with a way to approach our daily lives with greater efficiency and ease based upon the use of computer networks. It is clear that the rapid development of IT has made many contributions to the life of Korean citizens. However, the rapid development of IT also made it difficult for intellectual property holders in relation to IT to enforce their rights, because IT covers various technologies increasingly going in mixed and complex directions.

Thus, intellectual properties in relation to IT are becoming hard to regulate with a simple or single law. For example, the existing CA is not appropriate to protect all of the multimedia technologies, because it is mainly focussed on copyrighted works in conjunction with standard literary and artistic media. Also, a new central system should be designed for the control and management of rights in connection with manufacturing and distributing multimedia titles, and existing intellectual property systems should be changed accordingly. In sum, it is hard now to find adequate legal grounds to be applied to protect the intellectual properties relating to IT.

In view of the above situation, opinions in Korea are growing that a proper legal system should be established to protect intellectual properties in relation to IT which is distributed in the form of digitalized information, such as virtual space (i.e., cyberspace) in the computer communications field, and which is widely and quickly spread to concerned people all over the world.

3. Inappropriateness of Regulatory Protection

As manifested from the above, some of the regulations in connection with IT provide mainly certain provisions as to the requirements for permission and registration, etc. No one can use the technology without such permission of or registration at the relevant authorities.

However, these regulatory statutes themselves do not establish an independent cause of action for the person who created the system or work. Also, as a condition for such permission, etc., in many instances, the authorities require an approval or a license from the holder of intellectual property rights in connection with the IT.

In sum, regulatory statutes can regulate only in connection with the permission, approval, registration, licensing, etc. of the use of IT. Thus, the protection provided by regulatory statutes cannot be sought by the holders of rights related to IT in a direct manner, and so developers of IT may be protected only in an indirect manner as a result. This limit of protection results from the intrinsic nature of regulatory statutes.

Further, such regulatory statutes are usually inappropriate or unable to protect substantially and effectively new technologies which are developed continuously and quickly, such as IT. For example, computer software is protected by the CPPA which gives similar protection to that of the CA. However, it is possible that as the wide utilization of computer software becomes much easier than ever and new computer software is easily created without infringing known computer software, effects which would be the same as infringing effects under the CA cannot be protected against under the CA. Thus, a need for reconsideration as to the methods of protection of new computer software is gradually growing in Korea.

Based on the above, I believe that it is high time for Korea to adopt resilient legal systems to cope with and regulate newly developing and occurring technologies, such as IT.

B. Various Considerations to Promote Appropriate Protection of IT

1. Worldwide Protection

The principle of territoriality is basically applied to patents, copyrights, and other types of intellectual property. Owing to the said principle, the IP laws of each country apply to the subject inventions or works, in the country's territory. As a result, there may arise a problem that working or use may constitute infringement of IP in one country, while not in another country. I believe that is why it is very important and necessary to harmonize IP laws of all countries with each other, especially by integrating provisions such as those with respect to the limitation of the inventor's or creator's rights, and to rights to preserve the integrity of a work.

In addition, I think that harmonized legal regulations are urgently required to deal with sharply increasing problems, such as the problems of the ethical aspects of information and of respect for privacy, etc. I opine that harmonized legal regulations are also urgently needed to prohibit dissemination via IT of immoral information such as pornography, which is being distributing all over the world through the Internet.

If mass accumulation of private transaction data by use of credit card records, etc. is allowed, there is a high possibility that the thoughts or activities of a certain person may be revealed publicly and thus, his privacy is subject to being infringed. In this case, the danger may occur that due protection of privacy and private data cannot be secured in various countries, if there are substantial differences amongst the legal systems on privacy, etc. in each country. Thus, a new international treaty or amendments to any existing treaties, to mitigate such differences amongst the relevant countries and to establish uniform rules, is also urgently necessary.

2. Monitoring Systems

Currently, a suggestion is afloat to solve the copyright problems arising in connection with multimedia, with the help of up-to-date technology. With such technology, a copyright holder can get royalties from the user of his copyrighted work, after registration of and payment for his copyrighted work. In this connection, at the present level of technology, it is possible to control the use of information which is transmitted and received via networks.

3. Control of Digitalization

Digitalization, which is one of the characteristics of IT as discussed in detail above, has enabled individual persons to copy copyrighted works very easily and simply in a private area. As a result, digitalization has made it impossible to protect the right holder in respect of a copyrighted work properly. Such ease of copying affects copyright holders, so as to likely decrease their willingness to engage in the creation of works.

Thus, it is also urgently necessary to restrict such ease of copying due to digitalization. In this regard, technologies, e.g., technology for limiting access, technology for the prohibition of copying, technology for the limitation of use, and technology for proving the completeness of specific data of a right holder, etc. are being continuously studied.

If the useful technologies mentioned above can be used, an effective solution to illegal copying and usage activities can be sought, because it is then possible to know the status of issues such as registration and know the right holder, etc. in connection with copyrighted works, to ease the authorized usage of copyrighted works, and simultaneously to control the improper activities of the unauthorized copying and usage of copyrighted works.

4. Limited Protection of Ideas

Sometimes, it is necessary to give incentives for activities such as gathering and/or editing of non-work information, by way of payment of royalties for the use of non-work information or facts which do not deserve protection under copyright law. Thus, certain methods should be discussed in order to give limited protection to such information and use, if the information or facts have value so as to deserve protection as property. I believe that such limited protection will make the scope of protection relating to non-work information, and thus the usage thereof, much wider.

5. User's Right to Access

A user who wishes to use intellectual property in connection with IT must get the permission for such use from the right holder. However, if a license agreement cannot be reached between the user and the right holder due to non-agreement on conditions of use or on royalties etc., or if a license agreement itself is impossible, the proposed user cannot use the intellectual property, which is inconsistent with the public benefits intended to be an object of the intellectual property system.

For example, in order to make multimedia products, it is common for a user to use derivative works made from an original one. In such a case, the user should get a license from the copyright holder of the original copyrighted multimedia and from the copyright holder of the derivative copyrighted multimedia as well, which requires much time and money and thus makes difficult the public use of many useful applications therefrom.

To avoid such a problem, a system compelling the right holder to give a license to use his right is necessary, with the condition that some requirements are met. Of course, the user must pay a proper royalty to the right holder. Such a compulsory license system is also useful to the right holder, because he can get royalties easily from the user using his rights which are subject to free use, especially in the field of copyrights. In this regard, although the CA in Korea has a few provisions relating to compulsory licenses, the scope of compulsory licensing should be broadened in the CA.

In order to broaden the user's rights to access IT through a compulsory license system, it would be necessary to have an infrastructure in the way of a massive database containing information as to right holders, conditions of use, royalties, technical aspects, etc., and to perform the business of granting permission for use well, by adopting methods for procuring wide and frequent use.

6. Central Management

Usually, some complicated procedures are required in order to use intellectual properties relating to IT, and substantial efforts are also required to protect the intellectual properties. This environment creates a need for a new system for controlling the use and licensing of intellectual properties. To this end, the promotion of certain central control groups is suggested.

In this regard, a central control group named the "Korea Music Copyright Association" has already been operating in the music copyright field in Korea. Also, some agencies performing tasks to get permission for the use of published works exist. In addition, copyrighted works are being used and controlled through the "On-Line" system in Korea, if the information is transmitted and received by organized PC communication systems such as "Cheollian" or "HiTel", etc.

Such a central system provides both right holders and users a benefit, in that the right holder has more opportunities to let its rights be used, while the user can easily get a license from the right holder.

7. Legal Effects of Standardization

There is a question as to whether an exclusive right should be granted to a standardized technology, because standardization is not just a matter at the personal or corporate level, but a matter at the governmental and societal level.

For example, the MIC announced that it decided upon CDMA technology instead of TDMA technology as a standardized technology for mobile telephone services or personal communication services ("PCS"), in early October 1995. Korea Telecom ("KT") immediately retorted with a superficial reason that the PCS cannot be provided then within three or four years, considering the current speed of development of CDMA technology, if CDMA technology is adopted. However, the real reason is that KT has resorted to TDMA technology and thus it cannot have a superior position to that of competitors, if the MIC's decision stands. This means that the corporations developing CDMA standardization can enjoy strong rights which are substantially equal to exclusive rights. Further, there is the danger of misuse, due to standardization.

In this connection, the MIC, under the authority of the CNNPA, announced on October 16, 1995 that it established a "Directive on Standardization of Information and Communication and Intellectual Property" (the "Directive"). According to the Directive, an offeror of a standardization technology should give notice to the Telecommunications and Technology Association ("TTA") and/or the National Computerization Agency ("NCA"), if it has been determined there exist intellectual properties (e.g., patent rights, utility model rights, design rights or copyrights) in conjunction with the standardization, after searching the intellectual properties. Even in the case of a non-offeror of standardization, the same procedure as that for an offeror as stated above is also applied to a non-offeror, if the non-offeror recognizes the existence of the intellectual properties concerned.

If the TTA or the NCA is given notice, internally or from an offeror or a non-offeror of standardization, of the existence of the intellectual properties, the TTA or the NCA can request the intellectual property right holder to submit a certificate to the effect that "the right holder permits the use of his/her/its rights non-discriminatively, royalty-free or under reasonable royalty conditions." If the contents of a submitted certificate are adequate, or (in the case of the non-submission of a certificate) if a standardization draft containing an adequate substitute technology is submitted, the TTA or the NCA can permit the standardization technology in question.

The Directive also provides that disputes in connection with intellectual properties, etc., should be settled only by the right holder and the user, and without the intervention of the TTA and the NCA. Even if intellectual properties in conjunction with a standard are found after the establishment of the standard, the same procedure on standardization as discussed above is applied thereto.

The MIC expects that the establishment of the Directive will be a cornerstone for activating standardization in the information and communications field. The MIC also hopes the Directive makes a substantial contribution to the supply and wide use of standardized technology, by reducing the possibility of conflicts which may arise from the existence of intellectual properties relating to the standard.

8. Protection from Unauthorized Transmission

Development of IT has allowed information to be transmitted without too many limitations or controls. In such a case, a right holder cannot prohibit many acts of unauthorized transmission made by third parties. Such IT transmissions may strongly induce an infringement of the concerned intellectual properties, but there is no legal basis to prohibit such transmissions under the existing legal system.

A technological approach may be considered, to solve such transmission problems. However, such a technological approach is insufficient to prohibit unauthorized transmissions of information, because new or other types of transmission technology can be designed soon after the development of the first technology.

Thus, I think that, at present in Korea, legal measures should be considered in connection with the unauthorized transmission of information, with the help of any new transmission prohibition technologies. Specifically, I suggest in this regard to grant a right holder the right to receive royalties from third parties who transmit, in an unauthorized way, information relating to the right in question. Alternatively, introduction of "transmission" as constituting one additional type of infringement act, in the relevant laws and/or regulations, may be considered.

V. Conclusion

As discussed in detail above, the combination of the development of digital technology which can provide perfect copying capabilities without limitation and the establishment of the infrastructure of the information and communications superhighway has created big challenges to the efficacy of existing IP-related laws, which did not anticipate such rapid developments in IT. Further, infringements can be accomplished too easily and too frequently, with the help of the development of technology. Thus, adequate and effective legal measures are not easy to take, because enactments of or amendments to IP laws always lag behind the speed of the development of technology.

Also, the regulatory laws in Korea as well as other countries, due to their inherent nature, are not adequate to protect properly the rights relating to IT, although I should not underestimate their role and contribution by filling certain gaps between technological developments and existing IP laws. On the other hand, if protection for right holders or creators is too much the focus, there may arise side effects such as the obstruction of the public supply and/or spread of information. This means that mankind cannot enjoy fully the benefits resulting from the making of tremendous efforts to develop computer and communications technologies.

Accordingly, the most important things in the protection of intellectual properties in connection with IT are basically harmonization, and a balance between the technical advances of digital technology and network technology and the protection of the right holders thereof.

The advent of the challenges that new information technologies pose to the existing IP laws requires both the change or the supplementation of the existing IP laws, and the help of new information technologies. Thus, various attempts at infringing intellectual properties in relation to IT should be intercepted by both technical responses and the consolidation of legal systems internationally. The international harmonization should occur worldwide, after establishing and setting forth the scope and degree, etc., of the subject matters to be protected (including of intellectual property protection as well), considering the current situation of the existing IP laws and regulatory statutes.

In conclusion, I wish to propose the formation of special committees at the national level, as well as at an international level, to promote legal standards for the protection of various different sorts of information technologies for a short protection period, e.g., from a 3 to a 5 year term, which can be extended in accordance with technological developments and market situations. I further propose that new, adequate legal methods, such as the grant of rights for the protection of new and different information technologies separately and distinctly, be seriously considered at this time.

1/ The author wishes to give thanks to Byeong-Ok Song, Esq., and Paul S. Penczner, Esq., of Aram International Law Offices, Seoul, Korea, for their substantial contributions to the preparation of this presentation.

Scrambling Digital Images for Distribution through Networks

Hiroshi Fujii, Noburou Taniguchi, Yasushi Yamanaka
NTT Information and Communication Systems Laboratories
Yokosuka, Japan

Abstract

In distributing multimedia information, piracy protection is important because digital data can be easily duplicated. This paper presents a multimedia information distribution model using scrambled images and moving pictures and describes how the image data are scrambled. Scrambled images are distributed on a network, and users can get the original by purchasing descrambling keys from the copyright holder. The original image cannot seen without the descrambling key, therefore illegal copying is prevented and the author can charge for the use.

1. Introduction

Improved CPU performance and the development of efficient compression methods for image data like JPEG[1] or MPEG[2] have made it possible to deal with digital still images and moving pictures easily even on personal computers. Currently, image data is mainly distributed by CD-ROM in multimedia personal computers. From the viewpoint of communication, online shopping through networks are now beginning to be offered. In combination with these advancements, as high-speed network become widespread by B-ISDN, the distribution of multimedia information including still images and moving pictures will become one of the largest applications of the digital networks.

In distributing multimedia information, piracy protection is important to authors and information providers. Digital data can be easily duplicated without losing quality and can be easily distributed through networks. Therefore, there is a need for methods that make illegal copying impossible. Cryptography is commonly used for this purpose.

On the other hand, users should be able to evaluate information before they purchase it. Unlike physical objects, information cannot be offered for trial use because it might be copied without payment. So a data sample with a level of quality lower than the original, i.e. recognizable but not clear enough for practical use, should be provided. Cryptography is inappropriate for this purpose because it does not allow the user to view the sample image.

This paper presents a scrambling method for digital images and introduces a distribution model using the scrambled images. In the model, scrambled still images or moving pictures are offered at a low price or for free. To see the originals, users have to purchase descrambling keys from providers. Providers can control the distribution of image data by managing the keys.

2. Distributing image data through networks

Imagine a network distribution system of image data composed of providers of "parts", integrators and users. The providers hold the copyrights to the image data and provide images through networks. Integrators produce multimedia products by combining and editing the image data, and then offer them also through networks. They purchase the parts from the provider. Users purchase multimedia products or image data.

In distributing digital data, it is important to prevent illegal copying and guarantee compensation to copyright holders[3]. In addition, in order to activate the distribution from the user's side, samples should be made available to users so they can evaluate the image before purchasing it. The samples also serve as an advertisement. A scrambled image, a deteriorated version of the high quality original, is used for the trial version, and the original is regenerated by using descrambling keys.

Figures 1 shows three possible distribution scenarios.

Provider--User

Figure 1(A) is the case where a user purchases a still image or a moving picture from its author. The user decides whether the image or picture would be worthwhile by viewing the scrambled sample. The user can then purchase the key from the author to descramble the image.

476

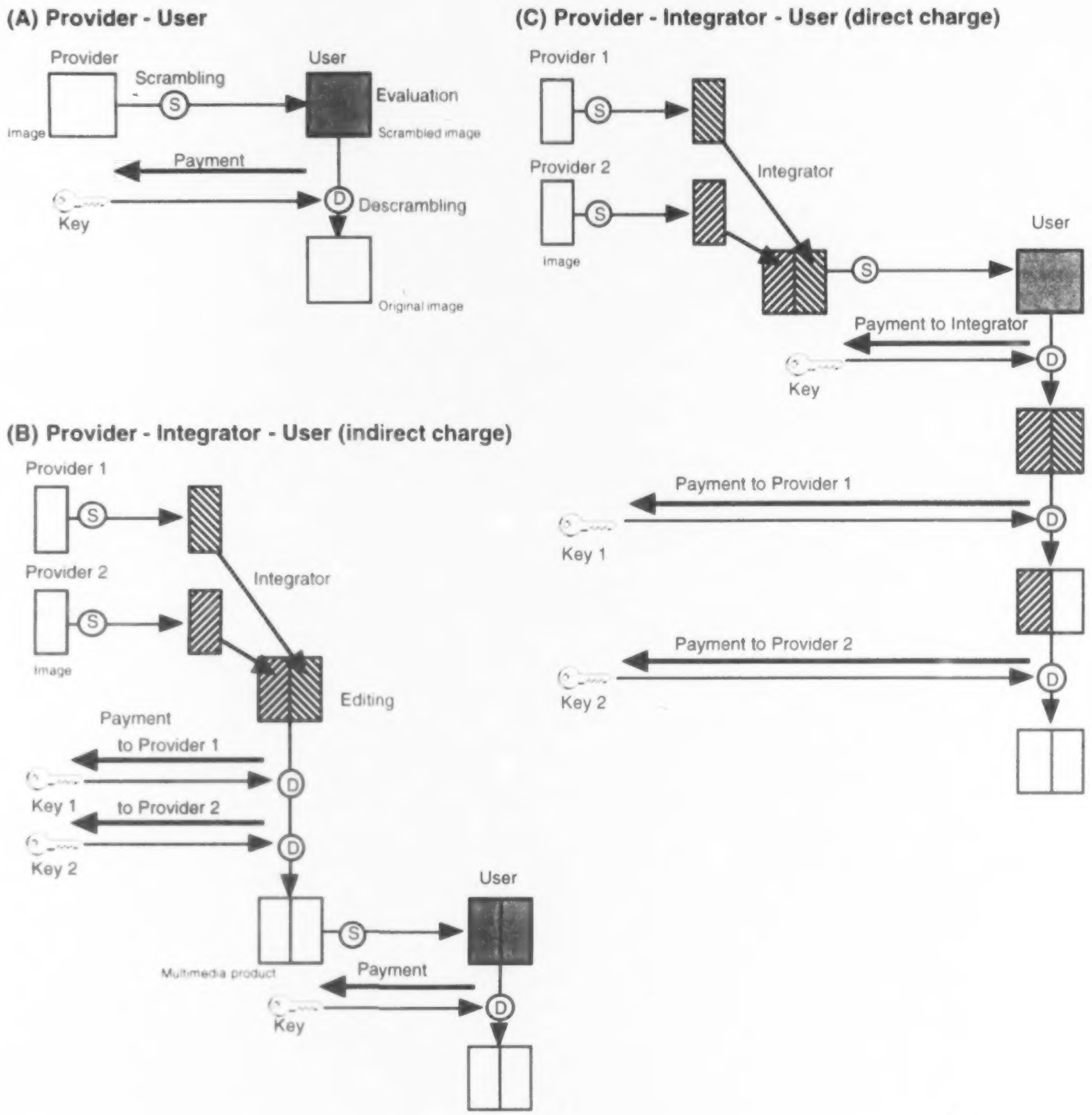

(A) Provider - User
Provider
Scrambling
S
User
Evaluation
Image
Scrambled image
Payment
Key
D
Descrambling
Original image
(C) Provider - Integrator - User (direct charge)
Provider 1
S
Provider 2
S
Integrator
Image
S
User
Payment to Integrator
Key
D
Payment to Provider 1
Key 1
D
Payment to Provider 2
Key 2
D
(B) Provider - Integrator - User (indirect charge)
Provider 1
S
Provider 2
S
Integrator
Image
Editing
Payment
to Provider 1
Key 1
D
to Provider 2
Key 2
D
User
S
Multimedia product
Payment
Key
D

Figure 1. DISTRIBUTION USING SCRAMBLED IMAGES.

Provider--Integrator--User (indirect charge)

In Figure 1(B), an integrator makes a multimedia product using images to which others hold the copyright. The integrator searches for the most suitable images for his product through the network by making the product on trial with scrambled trial version of the parts. When the package is assembled, the integrator purchases the descrambling key for each part and completes the multimedia product.

The integrator descrambles the parts and scrambles the product again when it is distributed. Users who desire the product do not purchase the descrambling keys from the copyright holders of the parts but purchase from the integrator. Compensation for the parts should be paid to the copyright holders by the integrator when the product is made, or after distribution according to the usage.

Provider--Integrator--User (direct charge)

In Figure 1(C), an integrator makes a multimedia product using parts as described above, but does not descramble the parts even when the product is completed and offered on the network. Instead, the whole edited image is scrambled. Users purchase the key for each image or moving picture in the package directly from the respective copyright holder.

This model enables authors of images to get the compensation from the users directly. If the integrator simply assembles the images or moving pictures into the multimedia package without editing them, such as in hypertext, each part is descrambled separately using the appropriate key at the user's terminal when it is played back. Authors can easily manage the descrambling keys as (C).

On the other hand, if the parts are edited, i.e, if an image is inlaid into another image, the keys will not work for the generated image after editing. Therefore, without generating a new scrambled image and new keys, the type of which depend on the editing process, direct management of use is impossible. The data transforming method discussed below, besides making image scrambling possible, also provides this function.

3. Requirements for scrambling

Users play back the trial version and original in the same way. The only difference is that the quality is low without the descrambling key. Therefore, the trial version and the original must be expressed in the same digital compression code. Moreover, the transformation must ensure that the trial version is simultaneously descrambled while it is being played back to prevent local filing of the descrambled data. Once the original is stored in the local file system, it is very easy to spread the pirate version.

We have developed methods for scrambling and descrambling digital image data coded by JPEG or MPEG, which are the respective coding standards for still images and moving pictures. The transformation from the original to the scrambled version and vice versa can be done directly without an intermediate stage, and the amount of computation is very small. Scrambled images are also coded in JPEG or MPEG like the original. This paper focuses on the scrambling of JPEG data, but the techniques involved can also be applied to MPEG.

4. Scrambling JPEG data

4.1 JPEG encoding process

In JPEG, image data are compressed through discrete cosine transform (DCT), quantization, and entropy coding by the baseline sequential process, as shown in Fig. 2.

Images are divided into blocks of 8x8 pixels, then each block is transformed by the forward DCT into 64 values, called DCT coefficients, which correspond to frequencies and make an 8x8 matrix. The top left coefficient is the DC coefficient and the others are AC coefficients. The AC coefficients are placed from the left in increasing order for horizontal frequencies and placed from the top in increasing order for vertical frequencies.

Each DCT coefficient is divided by the corresponding value in the quantization table, which is also an 8x8 matrix for quantization.

The quantized DCT coefficients are converted into a

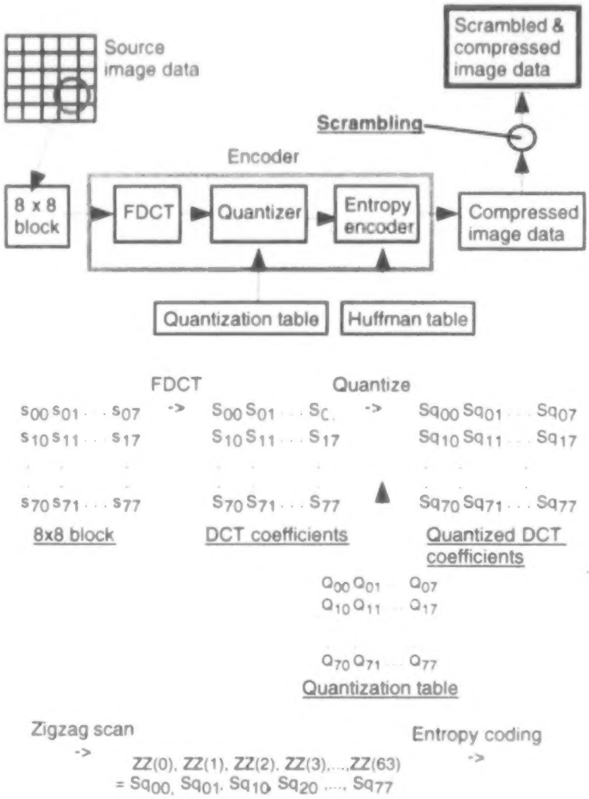

Source image data
Scrambled & compressed image data
Scrambling
Encoder
8 x 8 block
FDCT
Quantizer
Entropy encoder
Compressed image data
Quantization table
Huffman table
FDCT
Quantize
->
->
$s_{00}\, s_{01} \cdots s_{07}$
$s_{10}\, s_{11} \cdots s_{17}$
$s_{70}\, s_{71} \cdots s_{77}$
8x8 block
$S_{00}\, S_{01} \cdots S_{C.}$
$S_{10}\, S_{11} \cdots S_{17}$
$S_{70}\, S_{71} \cdots S_{77}$
DCT coefficients
$Sq_{00}\, Sq_{01} \cdots Sq_{07}$
$Sq_{10}\, Sq_{11} \cdots Sq_{17}$
$Sq_{70}\, Sq_{71} \cdots Sq_{77}$
Quantized DCT coefficients
$Q_{00}\, Q_{01} \cdots Q_{07}$
$Q_{10}\, Q_{11} \cdots Q_{17}$
$Q_{70}\, Q_{71} \cdots Q_{77}$
Quantization table
Zigzag scan
->
ZZ(0), ZZ(1), ZZ(2), ZZ(3),...,ZZ(63)
$= Sq_{00}, Sq_{01}, Sq_{10}, Sq_{20}, \ldots, Sq_{77}$
Entropy coding
->

Figure 2. ENCODING IMAGE DATA.

sequence by scanning in a zigzag fashion. Coefficients in the sequence are denoted ZZ(0) through ZZ(63) according to their order in the sequence. Then the sequence of DCT coefficients are entropy coded by Huffman code. The pair of the non-zero coefficient and the run length of zero coefficients before the non-zero coefficient is coded. The non-zero coefficients are grouped by their absolute values in the step of 2^n for $n=0,1,2,...$ The groups are called categories and referred by *SSSS* (*SSSS*=0,1,2,...). Category *SSSS* includes 2^{SSSS} values, so *SSSS* additional bits follow each Huffman code to specify the exact value of the coefficient in the category.

For example, let ZZ(1)=4, ZZ(2)=ZZ(3)=0, and ZZ(4)=3. Then category *SSSS*=2 for ZZ(4) because $2^1 < ZZ(4) \le 2^2$, and run length of 0 before it is 2. Suppose the Huffman code word for this combination is '11111001', then ZZ(4) is expressed as '11111001 11'. The last 2 bits are the additional bits.

4.2 Data transformation for image scrambling

With our approach, bit strings of compressed image data are transformed directly as shown in Fig. 2. In this subsection, the process by which the parts are selected for transformation and the transformation method are shown.

4.2.1 Selection of the transformed part

Each combination of 0 and 1 in additional *SSSS* bits specifies a different value of coefficients in category *SSSS*, and all bit strings whose length is *SSSS* are permitted as additional bits. Therefore, the value of arbitrary additional bits can be altered while keeping the JPEG data format, though the values of coefficients represented by them change within the category. So any additional bit can be selected for transformation. For example, the last two bits in the code word '11111001 11', which express ZZ(4) in subsection 4.1, can be changed to an arbitrary two-bit string, that is, '11111001 00', '11111001 01', and '11111001 10' are correct code words expressing -3,-2, and 2, respectively.

Now we consider the selection of transformed bit in the additional bits to be changed. We select additional bits coding ZZ(n) for n larger than k. The frequency represented by ZZ(n) increases with n and the eye is less sensitive to higher frequency, so scrambling is stronger when additional bits for the smaller k are changed. Here, k is a parameter used to determine the degree of scrambling: the quality of images can be adjusted according to the payment from the user.

4.2.2 Modification of data

Arbitrary transformation of a bit string which keeps its length can be applied to scramble additional bits. There are two main ways to do this.

Cryptography:

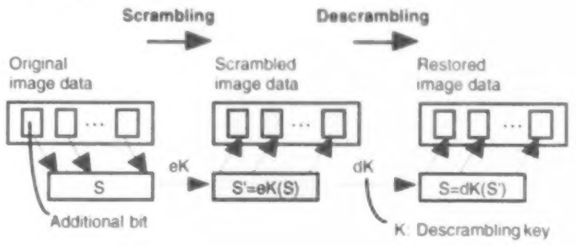
Let S be a bit string constructed from all the additional bits selected for scrambling, and let eK be the encrypting function which transforms a bit string, keeping its length. Image data is scrambled as follows. Generate S', such that $S'=eK(S)$. Then each bit in S is replaced with the corresponding bit in S'. In order to descramble, decrypting function dK is used. Original data is restored by replacing S' with S, such that $S'=dK(S)$. The decrypting key K is provided by the copyright holder as the descrambling key. (Fig. 3(A))

Replacement by a constant string:

Replace all bits in S with 0. The removed bit string S is recorded by the copyright holder and given to the user as the descrambling key. S is written back for descrambling as shown in Fig. 3(B).

Figure 8 shows an example of a transformed image. (A) is the original and (B), the scrambled image.

(A) Cryptography



(B) Replacement by a constant string

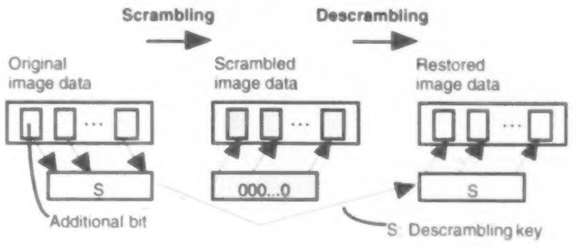


Figure 3. SCRAMBLING AND DESCRAMBLING.

4.3 Descrambling for distribution

JPEG encoded bit strings are scrambled and descrambled directly, and pixels of images may not be generated, therefore the data transformation can be done very effectively.

To stop illegal copying, users must be prevented from storing the original data. This can be accomplished by making sure descrambling is done in a tamper-free region when the image is displayed on the screen. With our method, scrambling is canceled between the entropy decoding and dequantization stages, as shown in Fig. 4, so it can be executed in the JPEG decoder hardware without interfering with the decoding process. Even when descrambling is done by software, no temporary file of the original JPEG data can be made. The result is good protection against piracy.

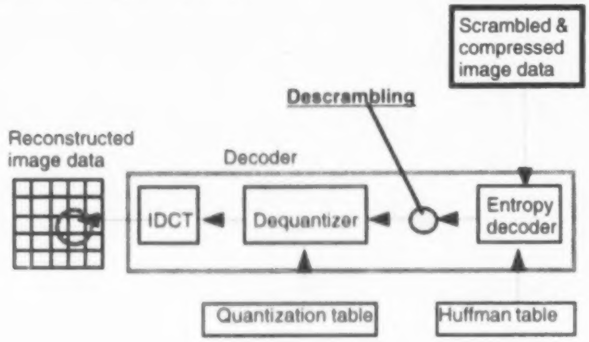


Figure 4. DECODING IMAGE DATA.

4.4 Multiple scramblings

Image data is divided into 8x8 pixel blocks and the coding process is applied to each block, therefore the image area to be scrambled can be selected in terms of 8x8 blocks. For example, in Fig. 5, only shaded blocks are scrambled. Scrambling can be applied repeatedly because it does not change the data format. This figure also shows an example where an image is scrambled three times and the scrambled area increases in size each time.

Multiple scramblings like this are used to control the quality of images according to payment. The scrambled area decreases as payment increases (see Fig. 5). The price of each key is determined separately; keys that enable important parts of the image to be seen are more expensive.

This technique can also be used for copyright management. When an image composed of parts from several authors is distributed as shown in Figs. 1(B) or (C), each part is scrambled by the respective author separately, as shown in Fig. 6. In this case, scrambled areas may overlap, and all descrambling keys are necessary to get the original. Direct billing by the authors of the parts for their use is possible even if the formats are edited for a multimedia package.

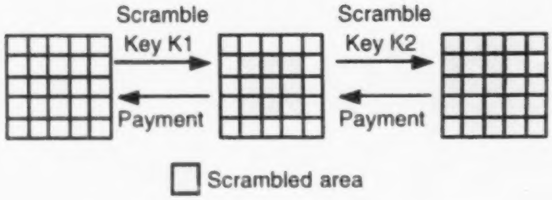


Figure 5. MULTIPLE SCRAMBLINGS.

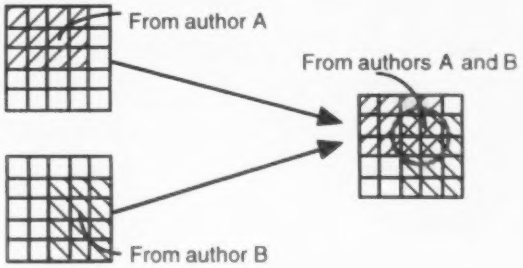


Figure 6. SCRAMBLING BY AUTHORS.

5. Experimental system

We are developing an experimental distribution system using the scrambled images discussed above. The system is composed of a center system, user terminals, and provider terminals, as shown in Fig. 7. Providers register scrambled images or moving pictures and their descrambling keys on the center system from their terminals. Users can then purchase those images or moving pictures from user terminals. This system includes a scrambler and descrambler for JPEG and MPEG data. This software transforms compressed digital images based on the scrambling condition or descrambling key. It can specify the scrambling conditions for each frame of moving pictures. There is also a moving picture editor that directly generates scrambled versions by combining frames in arbitrary data formats. A viewer for scrambled JPEG images or movies in motion JPEG format, which does real time descrambling with software without making temporary files of the original data, is also provided.

6. Conclusion

This paper presented an image scrambling method and showed how images can be distributed using scrambled trial version. The best way to ensure piracy protection, which is indispensable in the distribution of multimedia information on networks, is for the authors themselves to be able to control how the images they create are used. Scrambling provides this control. Parts of images used in multimedia products is difficult term of this control. Distribution model proposed in this paper also ensures the piracy protection in this case.

One of the difficulties in making multimedia products is searching for copyright holders and obtaining permission to reprint. Therefore, there is a need for a copyright administration center. Using our method, such a center could control how images are used by controlling the supply of descrambling keys. The scrambled images could be distributed freely and a user who wants to use a certain image could purchase the descrambling key from the author through the center.

References

[1] ISO/IEC 10918-1, 1994: Information technology -- Digital compression and coding of continuous-tone still images: Requirements and guidelines.

[2] ISO/IEC 11172, 1993: Information technology -- Coding of moving pictures and associated audio for digital storage media at up to about 1.5 Mbit/s.

[3] Mori, R., Kawahara, M.: "Superdistribution: the concept and the architecture", Transactions of the IEICE, vol. E73, No.7, 1990.

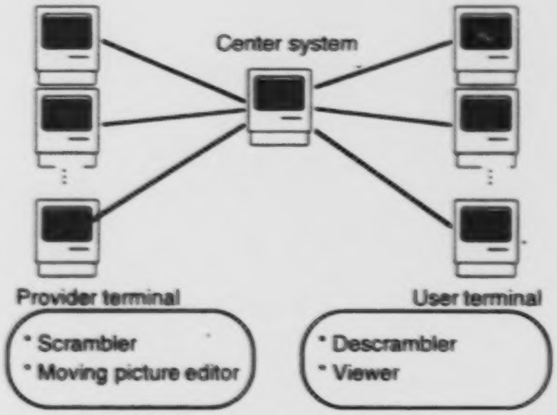
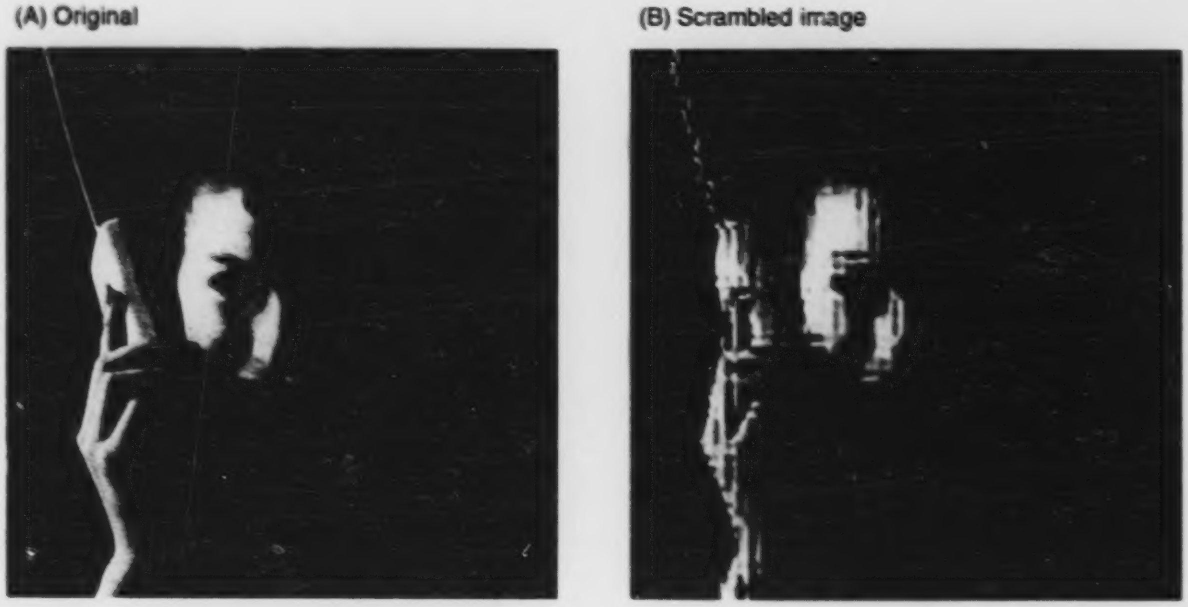


Figure 7. EXPERIMENTAL SYSTEM.


(A) Original

(B) Scrambled image

Figure 8. EXAMPLE OF SCRAMBLING

Preparation for New Information Society: From Regional Cooperation to Domestic Development in the Asia-Pacific Region

Whajoon Cho and Byoung-Woo Lee
Korea Telecom
Seoul, Korea

1. ABSTRACT

As the new information age is opened up, each country tries its best to strengthen its market power in telecommunications sector. New trade order of free competition is emerged in the telecommunications industry. APEC member economies in the Asia-Pacific region gathered to cooperate for the development of Asia-Pacific Information Infrastructure for co-prosperity of the region. Some general issues and critical points are discussed for successful efforts.

2. INTRODUCTION

Everyone expects unprecedented lifestyle changes in the 21st century. Magnitude of changes which the advancements in information and communications technology are bringing is often compared to that of the Industrial Revolution.

It is understood that the development of a national information infrastructure will improve a nation's competitiveness whether it be a developed or a developing country. Unemployment and low growth rates will be improved in the maturing economies, and industrial productivity will be enhanced in the developing economies. The information sector, where information machines are manufactured and information is produced, stored, processed, and distributed, is regarded to be a dominant part in the economy.

Each country is trying hard to prepare for the information age in order to keep and/or strengthen its power and status in the world. Internally most countries are setting up plans to establish their own national information infrastructure. NII in the United States, IT-2000 in Singapore, INFONAS in Indonesia, and KII in Korea are a few of the examples.

At the same time, various regional and global projects have been initiated by major countries and international cooperation is requested. The common goal of these projects is to complete interconnected, interoperable information networks for the free flow of goods, services, information, and knowledge. Though there are some differences, each project is composed of plans for improvements in hardware and software as well as for the establishment of institutions such as laws and practices to accommodate the new environments.

The APII (Asia-Pacific Information Infrastructure) is the representative cooperation project of the 18 APEC member countries.[1] The APII idea was put forth by the President of Korea at the Bogor APEC meeting in 1994. The previous Asia Information Infrastructure (AII) suggested by Japan can be merged into the idea of the APII, and the APII could be a major and vital component of the wider Global Information Infrastructure (GII). Through two Senior Officials Meetings (March and May, 1995) and one Ministerial Meeting (May 29-30, 1995) held in Seoul, Korea, the APEC member economies agreed on the objectives, principles, and some action plans for the establishment of the APII.

Nevertheless, what each country aims to accomplish through the APII can not be identical because of the unique situation of each country. The understanding of the national differences in the region is a prerequisite for the successful advancement of the APII. Careful consideration of the differences between the developed and the developing countries could induce active responses from the participating economies, and be useful to generate directions for the APII.

The current situation of each member country will be examined in the next part. Reasonable and proper approaches to accomplish the common goal of the APII will be deliberated considering the difference, and the role that Korean membership can play will be presented.

3. UNDERSTANDING THE DIFFERENCES AMONG COUNTRIES IN THE APEC REGION

Though the transaction volume and business potential in the APEC region is outstanding[2], there have been various undermining factors for the satisfactory reaping from the opportunities. There are wide variations in stages of technical development, human resources, and natural resources. The disparity in information infrastructures and the consequent information gaps, geographical constraints, and the cultural divergence among countries are often regarded as obstacles, too. The telecommunications environment is no exception. The seamless connection of the region with a high quality network is neither realistic nor useful unless the gaps are alleviated. The well-balanced development of regional communications through the effective information infrastructure will make it easier to achieve the APEC's long-term goal of liberalizing trade and investment by the year 2020.

The telecommunications environments of most of the APEC countries are briefly summarized as follows:

The Philippines has a low income economy with a meager phone density. Thus, the prospects of establishing its own information highway are slim as for now. The Ramos administration, however, called for deregulating the telecommunications industry to promote competition and investments, which is expected to bring new investments of up to US$13 billion and the creation of 160,000 jobs. An information sharing network for the government was established and tariffs on computers were slashed to 3 %.

New Zealand supports the idea of a small government in telecommunications policy. Except for the provision of adequate policies on market mechanism and some social and legal issues, the government is better be considered as a user of high level information services. Actual funding or provision of services has to be decided and made by the private sector following to the market demand. Currently 97% of the New Zealand telecommunications network is digitized and more than 90% of homes and offices are within 2 kilometers of an optical fiber node or ring. In addition, New Zealand is nearing completion of the installation of SS7 signalling technology, the application trials of ATM, and a number of fiber optic trials to schools and homes.

China's total office exchange capacity has reached 53 million lines, of which 97% is SPC exchanges. There are now 2.1 million mobile telephone subscribers. The national packet switched public data network covers more than 700 cities with its 60,000 ports and interconnects with the major international data networks and the domestic public telephone network. Foreign participation and ownership of networks is prohibited, but without it their plan to expand from 62 million lines to 140 million by the year 2000 may not be possible. In fact, major large carriers such as AT&T are aggressively exploring business opportunities in China.

In Chile, telecommunications is recognized as a key factor for economic growth and development. The regulatory body chose to eliminate all cross subsidies and to deregulate the industry. The local phone companies cannot provide long-distance and other services unless they are completely separated subsidiaries. Companies are free to set prices for the services they provide and guidelines for telecommunications equipment are broad in order to incorporate new technology rapidly. Even with a 20% annual growth rate and timely policy measures in the telecommunications sector, it cannot aspire to provide universal service in the short-term. Efforts are concentrated on providing universal access by increasing the number of payphones in rural and poor urban areas.

Hong Kong has already constructed 3 million exchange lines and 250,000 facsimile lines for 6 million people. The comprehensive fiber optic network and a fully digitized exchange system already provide the backbone of an information superhighway. Competition was recently introduced (June 1995) to the fixed network with the liberalization of international services and the establishment of a separate regulatory body.

Thailand's economy enjoys an annual growth rate of over 8% with inflation about 5%. Its plan for the NII is aimed at creating universal services nationwide with advanced telecommunications technology. It invests a considerable portion of its national fund in developing capable human resources. The Master Plan for National Telecommunication Development (March 1995) represents the position of the government on information infrastructure and the telecommunications industry. Its major components include universal services with fair tariffs, deregulation and private sector participation, and separation of regulating and operating functions of telecommunication entities. Aggressive telecommunications facilities expansion plans are being executed (6 million lines by the year 2001), and two domestic satellites are currently in service.

In Mexico, the telephone industry was privatized in 1990. The annual growth rate in the sector was 15% in 1994, and the phone density is now about 9.0. But the prices remain high compared to those in the U.S. and Canada.

Papua New Guinea, which has a population of 4 million, has a 1% phone penetration. Naturally, basic telephone service is of significant importance to them. It is not expected to actively participate in the APII, but it offers itself as a candidate for pilot projects suggested by other countries.

Indonesia, which has a population of 190 million, has 3 million phone subscribers. It has been operating its own domestic satellite system since 1976. The digitization of the network and the expansion of the optical fiber network within the major cities and between the 17,508 islands are under way. The industry is also being deregulated and privatized.

The United States sees the APII as a component of the GII. The dependence of the U.S. economy on the Asia-Pacific region is well recognized.[3] Thus, its main concern is in the free competition. Companies compete fiercely to demonstrate technical advantage to improve their market shares domestically and internationally. Digital interactive communications services via satellite will be offered in 1998 by Loral. CNN and CompuServe are teamed up to provide still video images and real time closed-caption text. The governmental regulation also reflects this movements so that the monopoly in the local market is no longer in effect.

As in the other advanced countries such as the United States., Canada, and Australia, the situation in Japan is different from those of the developing countries described previously. Japan is now concerned with the transmission of data in different formats via broadband network, the fiber to the home project, and the multimedia industry for bidirectional communications. In the process of securing a New Society Capital, Japan expects to create a huge multimedia market and 2.5 million new jobs.

The telecommunications network in Taiwan has reached the maturity of Korea. There are 8.5 million telephone subscribers with a penetration rate of 40%, 1.9 million radio pagers, and 0.6 million cellular mobile phones. Local/toll trunks are 100% digitized and 90% of the digital switching network is interconnected by SS7 links. The first cellular mobile phone network was introduced in 1989 and the latest GSM digital cellular telephony was just put into commercial services. Leased circuit services at various speeds are available and switching services can be accessed via packet switching network and frame-relay network. In addition, the country is actively participating in the investment and construction of worldwide international submarine cables with total of 29 cable systems.

In sum, the leading countries in information and telecommunications technology are vying for the international market and the developing economies are feeling the pressure of the ongoing market liberalization trend. However, it is hard for the developing economies to willingly accept the developed economies' liberalization suggestions unless they will bring employment opportunities and improvements in their living standards.

4. FOR THE SUCCESSFUL ESTABLISHMENT OF THE APII

As shown in the previous section, there are significant information gaps between the developed and the developing countries among the APEC members. The national strategies for informatization reflect their unique characteristics. Whereas the private sector plays a major role in the United States, the Korean government is playing the leading role in promoting the KII plan and pushing forward the first stage of the plan while requesting private sector involvement in later stages. The Singapore government leads both the form and the content of its IT-2000. The government of Japan is mainly concerned to the public network, but, in Korea, the strategies for public and government networks is separated.

In spite of all the differences, the interconnection and interoperability of the networks are essential for co-prosperity in the region. Even though there are controversies over the influence of telecommunications on balanced development,[4] the connection itself is unavoidable. All the members should cooperate because the APII is a task which no economy can undertake alone. The problem is how to accomodate the national differences in the expansion and utilization of the information highway to the mutual benefit of everyone.

The following issues need to be addressed if we are to achieve the desired outcome for the APII:

484

4.1 Financial Resources: The information super-highway requires considerable amount of money. Hardwares need to be constructed, adequate softwares must be developed, and the environment should be settled to guarantee free flow of useful information for the people who need it. According to the way each country involves in the APII and its own NII project, the financial resources need to be gathered both from the public and the private sectors. Public funding, whether it's internal or external, might be easier for the countries where the private sector is not capable. Not all the economies of member countries, however, are strong enough to establish all three dimensions; hardwares, softwares, and environments. The foreign capital could go into the financially weak countries as a form of ownership shares in information and/or telecommunications industry. The public nature of the industry, however, often put restrictions on the maximum size of foreign ownership shares. It should be recognized that the requests for sudden removal of those restrictions neither be realistic nor desirable. Rather the benefits like more jobs from influx of foreign capital needs to be perceived and understood.

4.2 Human Resources: The quantity and quality of human capital is considered as one of major factors for national competitive advantage.[5] Development of training and educational program, and exchange of human resources must be accomplished. It especially needs to be emphasized in the developing countries because human resources are indeed a fundamental base for successful expansion of basic telecommunication technology. Either for the APII or NII, its objectives can only rely on well trained personnel and expertise.

The desired direction of the support, therefore, usually goes from the developed to the developing economies initially. The expertise and knowledge cumulated in the developing countries will later facilitate bidirectional information flow within the region. Moreover, the facilitation of human resources development can be motivated without serious concerns on management power or ownership shares in telecommunications industry unlike the influx of foreign capital.

4.3 Technology: Joint research and technology transfer should be active among the member countries. Here again, the direction mostly goes from the developed countries to the developing ones. In order to avoid the technological subordination by the developing countries, the well-cooperated equipment standardization is another dimension to be considered. The guidelines for harmonization of equipment certification agreed at the APEC working group will contribute to the infrastructural development by providing support for the information industry and facilitating the trade of terminal equipments and the rapid deployment of new technology. The organization of "APII Test-bed Forum" with many people from various countries can be an excellent implementation strategy for accomplishing both technology transfer and human resources development.

4.4 Network: In order to facilitate the construction and expansion of the regional information infrastructure, the modernization of telecommunications infrastructure, and collaborative pilot projects (e.g., administrative information network) should be promoted. Whether the existing networks can be fully utilized or not for the APII depends upon various factors: the comprehensiveness, capacity, and speed of the network, the ability to raise required fund, the kinds and amounts of information that will travel on the network. Usually, more advanced countries are equipped with the more utilizable network and more fund, and vice versa. At the same time, the amount of information that will be used in the developing economies tends to be less than in the developed countries. Expansion of network capacity and coverage, therefore, should be proceeded after a thoughtful consideration on the balance between the cost and the benefit from it. Since, in some countries, satisfying the minimum requirements for the connection in the APEC region could be a good foundation for their national information infrastructures, whereas any expansion is not likely to be compensated in the very near future in other countries.

4.5 Content/Information: Even though we recognize that some information is universally beneficial and the open access is very important, individuality needs to be emphasized here. Unconditional openness may lead to a flood of homogeneous global products that jeopardizes the national identities and independence. It is very likely to block the chance for each country to develop its own databases. The countries that receive the information all the time becomes subordinate to the countries that provide the information. The imbalance would become worse.

The kind of services provided through the network could be sufficiently country-specific so that the service efficiently improves the industry that is strong in the country. For example, the Philippines, where agricultural sector occupies 23% of GDP and food and beverage seize 36% of manufacturing, is recommended to make use of information/telecommunications services and networks for enhancing the productivity in those sectors. CATV services for sharing agricultural techniques, recent informations on market condition, and weather forecast through satellite communication will be useful for improving agricultural sector. Though the connection may not be totally voluntary, the clever application and utilization of the network are enough to generate beneficial results for all. With these in mind, active cooperation is required for the promotion of EDI, joint development of database, test-bed interconnection and information sharing, and societal implication of the information society among the economic entities that have common grounds.

4.6 Role of the Government: How intensively each government needs to be involved for the development of information infrastructure depends on the situation of each country. The most important role is to keep policies and regulations consistent so that they can encourage open and competitive environment. At the same time, the government has to help protecting intellectual property rights, personal privacy and security of information as well as setting up the standards for the content/information. Policy dialogues on the information infrastructure between the developed and the developing countries are needed to establish the rules for ensuring fair competition among member economies. Proper policy and regulatory measures lead to liberalization and removal of technical and administrative barriers to market access. And as results, they promote small and medium scale enterprises. In that sense, the government needs to be more active in the developing countries than in the developed ones.

5. KOREA INFORMATION INFRASTRUCTURE

In Korea, the government announced its strategy for the KII early in 1994. The required investment will be totaled up to US$60 billion in developing an information super-highway by the year 2015. The strategy is composed of three phases, of which the first part is to construct a government fiber optic backbone network that connects public offices, universities, and research institutes by 1997 with the public fund. Full utilization of the existing facility and networks is desired, and the government supports for developing the public application softwares. For the second phase (1998-2002), the public network will be built with the private sector investment. Large scale users such as industries, banks, airports, apartment complexes are to be connected with a high speed network that can interface with the existing ones as well as the one constructed in the first phase. Telemedicine, electronic libraries, and remote learning are good sample services for the stage. Finally, the completion of the nationwide information super-highway will be accomplished by the year 2010. The technology will be developed and led by the industry, and financial resources will be raised from the private sector.

The role of and support from the government is gradually weakened with the progress of the plan. It will mainly be focused on promoting fair competition in the information and communication sectors and continuing to open the market to take part in the emerging new world trade order. Further, it is now ready and willing to share its own expertise and technologies with other countries. The capability and willingness to help were the driving force to initiate the APII for the APEC countries and to lead the project as a qualified mediator among countries with diversity.

6. CONCLUSION

The Asia-Pacific region is emerging as a new economic center of the world, and thus a major engine of world growth. We need a new mechanism for regional cooperation to make the most of the ongoing information revolution. At this stage, it is hard for any country to survive if it is isolated from others. No one doubts the necessity for networking. Given the situation, regional cooperation in building APII is a must rather than a choice, even though the magnitude of involvement can not be the same for each country. There are wide variations in what each country can do for the APII as well as in the needs and priorities of what they want to get from the APII.

This diversity should be respected and reflected in each country's involvement in the project. The role of government, magnitude of private sector participation, and emphases on special dimensions of cooperation could be modified according to the unique interest and concerns of each country. Without this type of harmony, neither the APII nor national development can be achieved. For a better future for everyone, a spirit of mutual benefit and respect should be kept all the way through the completion and use of the APII.

Because of Korea's current level of development, Korea can mediate between the two groups of countries, the developing and the developed. Korea will do its best to promote harmony among the member countries for the successful expansion and utilization of the APII.

REFERENCES

Computer and Communications Promotion Association of Korea, Details of Comprehensive Plan for Information Super-Highway, March, 1995.

Draft Joint Statement, [APEC Ministerial Meeting on Telecommunications and Information Industry], May 1995.

Hwang, Doohyun, "The Strategy for The Information Society: South Korean and ASEAN Perspectives", The Korean Journal of Information Society, Vol. 7 No. 1. Spring 1995.

Keynote Speeches, [APEC Ministerial Meeting on Telecommunications and Information Industry], May 1995.

National Statistical Office Republic of Korea, Major Statistics of Foreign Economy 1994, Seoul, Korea.

World Economic Forum, The World Competitiveness Report 1994, Lausanne, Switzerland. September 1994.

Endnotes

1. They are Australia, Brunei Darussalam, Canada, Chile, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Mexico, New Zealand, Papua New Guinia, Philippines, Singapore, Chinese Taipei, Thailand, and USA.

2. The APEC economy accounts for 41% of world trade and 50% of the world's output.

3. US trade with Asia exceeds $374 billion a year, which accounts for approximately 40 percent of the total US global merchandise trade. An estimated 2.6 million American jobs depend on US exports to the Asia-Pacific region.

4. While some believe that telecommunications technology brings balanced development by removing the restrictions of time and space, others argue that the current imbalance will become worse. Because new services or technology usually are introduced from where the demands have formed to a reasonable size. Once it has started, it has a tendency to reinforce current structure.

5. Usually the minimization of transaction costs is mentioned as the other major factor.

Politico-Economic Analysis of the Japanese Information Infrastructure Initiatives*

Michael Latzer
Austrian Programme for Advanced Research and Technology - APART, Austrian Academy of Sciences
Vienna, Austria

1. ABSTRACT

This article provides an empirical-analytic survey of initiatives toward the Japanese Information Infrastructure (JII). The politico-economic analysis examines the policy network, interests involved, major strategies, plans and pilot projects, and discusses multidisciplinary factors which influence the choice of strategies and the degree of difficulty in their realization.

2. INTRODUCTION

Multimedia, that is to say the electronic info-communications market, has evolved into a central topic in the triadic competition between the USA, Japan and Europe. Highly promising market forecasts encourage companies; anticipated socio-economic impacts, including both opportunities and risks, motivate and alarm politicians and interest groups. At first glance, the initiatives toward the establishment of national information infrastructures show broad conformity, however, a politico-economic analysis reveals and helps to explain national/regional peculiarities, and the partially hidden agenda behind them.

3. BACKGROUND INFORMATION ON THE JAPANESE INFO-COMMUNICATIONS SECTOR

In general, the recent changes in the Japanese telecommunications and broadcasting sector reflect worldwide trends: liberalization, harmonization and privatization.[1] The policy network of the Japanese info-communications sector is outlined in Figure 1. This gives a rough overview of interconnections and major players involved in the JII initiatives.

The Ministry of Posts and Telecommunications - MPT is the central player in the sector. Its activities are not limited to post and electronic communications but also include a profitable postal savings and life insurance division. The Telecommunications Bureau, Broadcasting Bureau and Communications Policy Bureau are responsible for the regulation and coordination of activities in the electronic info-communications sector. The independent advisory councils: Telecommunications Council, Telecommunications Technical Council (Standards) and Radio Regulatory Council were established through the 1985 Telecommunications Business Law.

With the convergence of informatics and telecommunications, the Ministry of International Trade and Industry (MITI) gained influence in the electronic info-communications sector. Its main activity in the sector is the support of strategic projects.

Infrastructure- and service-providers can be broken down into international and national providers, and so-called "type 1" and "type 2" (special, general) carriers, which are subject to different regulations. Type 1 carriers own the facilities, type 2 carriers lease the capacities as needed. In January 1995 there were three international type 1 carriers, the former monopoly KDD and its two competitors IDC und ITJ. The National market leader is the type-1 carrier NTT, which is also, for example, active in mobile communications.[2] The three competitors in the national long-distance market are DDI, Japan Telecom and Teleway Japan. On the regional level, eleven companies offer leased-line services and are mainly backed by electricity companies.[3] The number of "general type 2 carriers" rose fastest; 2,101 general and 43 special type 2 carriers offered their services in January 1995.[4]

In the broadcasting sector the public broadcaster NHK is the market leader. It is also active in satellite broadcasting, alongside four commercial broadcasters. The five biggest commercial networks are NTV, TBS, CX, ANB and TX.

The main CATV companies are those in the railway sector (eg Tokyo Cable), trading companies and local government. In February 1995, 170 so-called urban type CATV operators offered multi-channel services.

Financial support for projects in the info-communications sector is mainly channelled through two independent, specialized government organizations. The Telecommunications Advancement Organization of Japan (TAO) and the Japan Keytech Centre.

4. JII-INITIATIVES

The central strategies and activities in the JII initiative come from the traditional players in the electronic info-communications sector, the Ministry of Posts and Telecommunications (MPT), the dominant telecom company NTT and the Ministry of Trade and Industry (MITI). The MPT establishes ad-hoc study groups for the analysis of specific topics, e.g. on Multimedia Mobile communication, Convergence of Telecommunications and Broadcasting, Digitalization of Broadcasting, Broadcasting in the Multimedia Age, Environmental Benefits of Info-communication, and Info-communications for the Ageing Society, it starts strategic initiatives and promotes pilot projects for infrastructure and applications development. Pilot Projects and Experiments supported by the MPT include the Multimedia Pilot Model Project, the B-ISDN Experiments, the Full-service Network Support Centre, Cable-Telephony and the Teletopia Project. NTT announced its vision of future info-communications[5] and presented its Basic Concept and Current Activities for the Coming Multimedia Age in 1994.[6] The MITI elaborated a Programme for Advanced Information Infrastucture[7] with the focus on the demand side, and the Programme 21 - Programme for Creating New Markets[8].

The CATV industry which is comparatively underdeveloped in Japan is gaining strength in the course of the JII initiatives. It is backed by the MPT, which wants a stronger CATV industry in order to create competition on the infrastructure level – in particular for the market leader, NTT. The JII involvement of the public broadcaster NHK and its commercial competitors is comparatively low and rather passive. New market entrants, made possible by the liberalization of telecommunications, tend to be active more in the second rank, mostly by means of increasing their share in info-communications companies.[9] Although the major changes are seen in telecommunications and broadcasting, other branches such as computer software, consumer electronics, game software, newspapers and publishers will also be affected. The future industry structure of info-communications will include a rising number of players, among which the software industry is expected to play a key role. Not only is there a convergence of telecoms and broadcasting, but other borderlines are also becoming blurred.[10]

The central JII vision of MPT, NTT and MITI show wide conformity regarding the motivation, the envisioned applications, the anticipated societal chances and new social problems of info-communications. More explicitly than in the US and in the EU, Japanese plans aim at an integrated broadband network connecting all households. According to the MPT plan, the network should be completed within 15 years, by 2010.[11] The timetable envisages three steps: (1) In the year 2000 all major urban areas plus schools, hospitals, community halls etc are to be connected nationwide (a diffusion of 20 per cent). (2) All cities with more than 100,000 inhabitants (60 per cent in all) by the year 2005. (3) Completion of nationwide fibre-optic network in 2010. With the help of various pilot projects and experiments, the technology is being tested, and attractive applications are being sought. The broadly defined info-communications infrastructure[12] is conceptualized as having four layers (see Figure 2). In order to utilize info-communications efficiently, a change in personal values, of life and work style, is explicitly called for, together with necessary changes in the physical infrastructure, information processing and application.The main hurdle on the way to realizing the positive vision of the info-communications infrastructure is expected to be the question of how to make the necessary changes in lifestyle and working style. Altogether, Japanese strategies imply a strong belief in the steerability of info-communication developments by the state. The political/administrative system with strong central power of the ministry at the local and national level, and an unusually close relationship between civil service and industry support this approach.

5. FACTORS INFLUENCING THE JII PLANS AND THEIR REALIZATION

5.1 GLOBAL COMPETITION AND HYPE

There is growing interaction between the information infrastructure visions and plans of the US, Japan and the EU.[13] Competition for the promising global info-communications market has already begun at a symbolic level. The choice of a homogenous fibre-optic network in the MPT plan, which is even more advanced and capable than its hybrid US and EU counterparts, seems to be motivated by the goal of outdoing US and EU strategies. However, it must have been clear that this was unrealistic. Even shortly after the publication of these plans, it became obvious that a hybrid solution was more likely to be the case in Japan as well. As in other countries, the Japanese discussion of multimedia and future info-communications is considered hyped, eg regarding the market prognosis. Critics observe a "multimedia fever" with vague or absent definitions of multimedia, overoptimistic market prognoses and underestimated cost.[14]

5.2 POLITICAL / INSTITUTIONAL ASPECTS

The government crises, the long discussed but still unresolved NTT reform, and the rivalry between MPT and MITI weaken the formulation and realization of current JII initiatives at different levels.

A political crisis with seven governments within five years demonstrates the problems of departing from a one-party-system. Moreover, there are crucial changes regarding management principles and the educational system.

The restructuring of NTT has already been discusssed for more than a decade. The MPT wants to divest the company in order to nurture competition. A decision on the NTT reform is scheduled for 1995.

According to experts, the rivalry between MPT and MITI concentrated on CATV in the 1970s, on telecommunications (value-added services) in the 1980s, and extended to multimedia/info-communications in the 1990s.

Organizational and institutional changes to improve the framework for JII initiatives are being discussed. However, the options to improve the coordination and administration by forming a new ministry, either an information ministry consisting of parts of the MPT and the MITI, or an infrastructure ministry, responsible for public utilities from various sectors, do not seem to be politically feasible in the short and medium term. A more pragmatic solution would be the formation of integrated committees composed of representatives of various ministries involved. In order to solve the convergence problems of telecommunications and broadcasting, a study group was formed which is elaborating a reform of existing telecommunications and broadcasting laws. In mid 1994 the Cabinet established the Advanced Information and Telecommunications Society Promotion Headquarters, chaired by the prime minister and vice-chaired by the minister of posts and telecommunications.

5.3 SOCIAL AND CULTURAL ASPECTS

As opposed to the USA and EU, there is hardly any public controversy regarding social consequences of the JII, which can be explained by the low priority generally given to the assessment of possible negative social consequences of technology in Japan, and by the negligible role of non-profit organizations/users in the political debate.

Broadly defined cultural factors are also in a process of change, which impacts on the utilization of info-communications, and hence on the realization of JII initiatives. The long cultivated management hallmarks[15] are also under discussion and there is an understanding that a sector by sector restructuring of society is needed, changing life and working styles to better utilize info-communications. Furthermore, experts foresee a step by step reform of the unique regulatory and administrative process in Japan, the dominance of administrative guidance, the lack of formal rules, pronounced flexibility in the decision-making process, the minor role of courts, and the close relationship between the administration and the industry.[16] The trend is expected to bring a gravitation towards the US pattern: more transparent decision-making mechanism, more formal rules, and stronger courts.

Another factor, which is generally interpreted as disadvantage for JII development, is the low penetration of computer networks, including internet, and, in particular, the extremely low diffusion of so-called urban-type CATV[17], which calls for different infrastructure strategies than in other countries. Table 3 illustrates the lag in Japan compared to the USA.

However, less well-defined societal/cultural factors are expected to compensate to some extent for other disadvantages. It is argued that there are sectors, where the Japanese came from far behind and finally did very well. In interviews and articles, success stories of the car industry, the banking and computing sector are cited as arguments that western scepticism regarding the feasibility of Japanese strategies has often proved wrong in the past. "... Japan started with zero 40 years ago and has accomplished in the last ten or 15 years what the rest of the world spent 100 years building."[18] Whatever the accuracy of this assessment, it is clear that JII strategies are not primarily demand-driven, but are informed by other factors and goals.

5.4 SECTIONAL INTERESTS - HIDDEN AGENDA

Summing up, the announced visions and plans of MPT, MITI, NTT and the government have shown a tendency to be driven by their sectional interests. The only partly hidden agenda behind the JII initiatives is the impending NTT reform, further liberalization of the telecommunications sector, the nurturing of new competitors in the market, the conflict of interest between ministries, the fight against recession and the restructuring of Japanese industry.

NOTES

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[1] For an analysis of the telecommunications reform see Sato 1994.

[2] NTT was partially privatised in 1985; however, the majority share is still held by the Minstry of Finance.

[3] Only TTN offers a switched telephone service. The railway companies back Japan Telecom and transport-sector companies (eg Toyota) back Teleway Japan. Altogether there were 87 type 1 carriers in January 1995.

[4] See MPT 1995, p 1.

[5] The NTT vision"Visual, Intelligent & Personal Service" was already announced in 1990.

[6] NTT 1994.

[7] MITI 1994b.

[8] MITI 1994a.

[9] Trading companies are increasingly investing in CATV, and electrical companies are backing telecom companies, but not very aggressively, which is partly explained by the monopoly situation in their core business.

[10] Nintendo, for example, has entered satellite broadcasting, buying 19.5 per cent of SDAB - Satellite Digital Audio Broadcasting. Furthermore it is cooperating with the US Silicon Graphics Inc, which specialises in multimedia applications. Sony has entered the games industry, aiming at the application of 3D graphics (International Business Week, 23 May 1994, p 21). Some sectors are already closely connected. All of the five biggest newspaper companies (Asahi, Yomiuri, Mainichi, Nikkei und Sankei) are active in broadcasting as well. There are crossowner restricitions (shares have to be below 10 per cent) which, however, are avoided by specific financial constructions of companies.

[11] The conceptual basis of the current MPT policy is the report "Reforms toward the Intellectually Creative Society of the 21st Century. Programme for the Establishment of High-Performance Info-Communications Infrastructure", which was elaborated by the Telecommunications Council. (Telecommunications Council 1994. The study group included experts from the industry, academia and the social partners.)

[12] The info-communications infrastructure is defined as "a comprehensive entity that encompasses network infrastructure, terminals, software applications, human resources, public and private info-communications systems, as well as social value and lifestyles related to the informatization of society." Telecommunications Council 1994, p 2.

[13] Hayashi & Sueyoshi (1994), for example, point out the importance of the NTT vision (Visual, Intelligent and Personal Communications Systems VI&P, announced in 1990) for the formulation of the US initiatives.

[14] Japan Times, 6 June 1994. In this article, Noboru Makino from the Mitsubishi Research Institute criticises the market forcast: The MPT prognosis suggests a multimedia market of 123 trillion yen in 2010, roughly 1.23 million yen per person. The automobile, steel and information industry (computer, software) has a market of only 10 trillion yen.

Other economists criticise the market forecast because it contains both intermediate goods and final consumption goods, thus some of the values are counted twice. A further criticism is that the forecast regarding employment effects only accounts for the creation of new jobs by the construction of the fibre-optic network (2.43 million), without taking into account the accompanying loss of old jobs.

15 The challenged management principles are, for example, lifetime employment, consensual decision-making, and seniority principle in strictly hierarchical systems.

16 For an analysis of the regulatory system see Glynn 1992, Marcus/Marcus 1994, Sato 1994, Sugaya 1995, Weinberg 1991.

[17] There are three criteria for urban-type CATV: (1) more than five original services (not including satellite programmes and Japanese terrestrial channels); (2) two-way communications capacity (not to be confused with interactive services!); (3) the number of potentially connected households is higher than 10,000.

The far bigger group of CATV is limited to the retransmission of terrestrial programs in areas with reception problems and cannot be upgraded to modern multichannel systems.

[18] Kazuo Nukazawa, managing director of the powerful industry association Keidanren, cited in Fortune, 13 June 1994, p 24.

REFERENCES

Aizu, Izumi (1994). New Information Infrastructure in Japan: a critical view, pp 33-38, in: Project Promethee Perspectives 1994 23.

Glynn, Simon (1992). Japan's sucess in telecommunications regulation. A unique regulatory mix, in: Telecommunications Policy 1992 16 (1), pp 5-12.

Hayashi, Koichiro (1993). Information infrastructure: Who builds broadband networks? Information Economics and Policy 1993 5 (4), pp 295-309.

Hayashi, Koichiro / Sueyoshi, Toshiyuki (1994). Information Infrastrucuture Development: International Comparison Between the United States and Japan with Some Implications for European Union Countries. Paper presented at the ITS European Regional Conference, Khania.

InfoCom Research (1994). Information & Communications in Japan 1993-1994, Tokyo.

Marcus, Michael J. / Marcus, Gail H. (1994). Japanese Regulatory Institutions and Practices. Working paper, Feb 1994.

MITI (1994a). Programme for Creating New Markets (Programme 21), 24 Feb 1994, Tokyo.

MITI (1994b). Programme for Advanced Information Infrastructure, May 1994, Tokyo.

MPT Ministry of Posts and Telecommunications (1994). Communications in Japan 1994, Tokyo.

MPT Ministry of Posts and Telecommunications (1995). Outline of Telecommunications Business in Japan, Tokyo.

NTT (1994). NTT's Basic Concept and Current Activities for the Coming Multimedia Age, Tokyo.

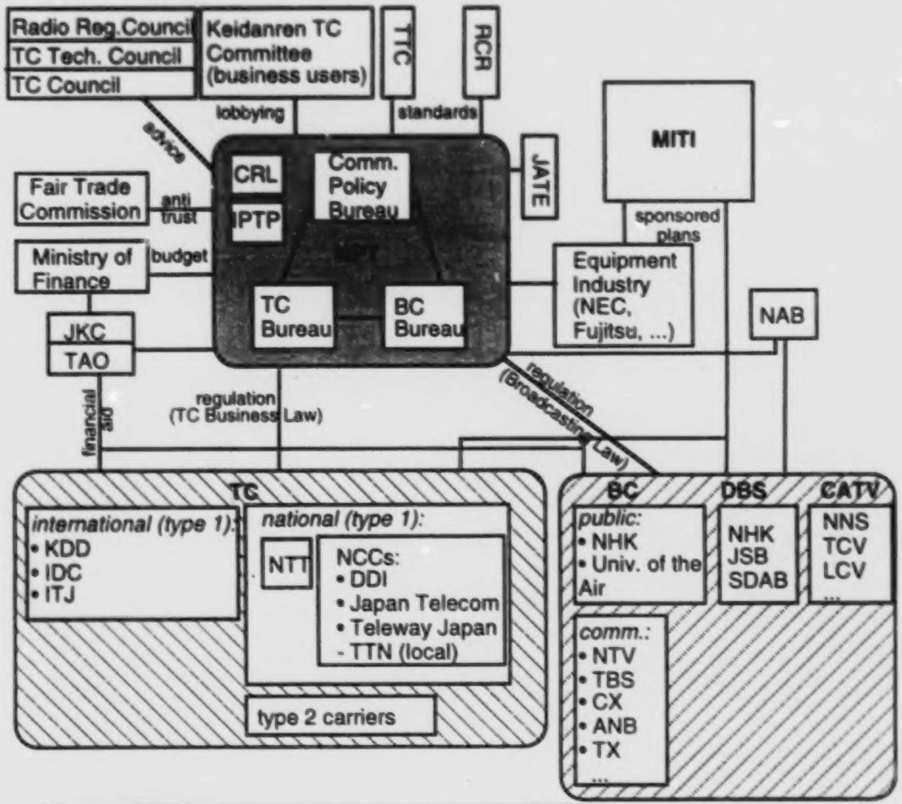
Sato, Harumasa (1994). The Political Economy of Japanese Telecommunications. Working Paper, Konan University, Kobe

Sugaya, Minoru (1995). Cable Television and Government Policy in Japan in: Telecommunications Policy 1995 19 (3) pp 233-239.

Telecommunications Council (1994). Reforms toward the Intellectually Creative Society of the 21st Century. Programme for the Establishment of High-Performance Info-Communications Infrastructure. Report (Summary), May 1994, Tokyo.

Weinberg, Jonathan (1991). Broadcasting and the Administrative Process in Japan and the United States, pp 615-733, in: Buffalo Law Review, 1991 3.

Figure 1: The Japanese electronic info-communications sector: major players, policy network


Radio Reg.Council
TC Tech. Council
TC Council
Keidanren TC Committee (business users)
TTC
RCR
advice
lobbying
standards
CRL
Comm. Policy Bureau
IPTP
JATE
MITI
Fair Trade Commission
anti trust
Ministry of Finance
budget
TC Bureau
BC Bureau
sponsored plans
Equipment Industry (NEC, Fujitsu, ...)
NAB
JKC
TAO
financial aid
regulation (TC Business Law)
regulation (Broadcasting Law)
TC
international (type 1):
• KDD
• IDC
• ITJ
national (type 1):
NTT
NCCs:
• DDI
• Japan Telecom
• Teleway Japan
- TTN (local)
type 2 carriers
BC
DBS
CATV
public:
• NHK
• Univ. of the Air
NHK
JSB
SDAB
NNS
TCV
LCV
...
comm.:
• NTV
• TBS
• CX
• ANB
• TX
...

BC	Broadcasting
comm	commercial
CRL	Communications Research Laboratory
DBS	Direct Broadcasting Satellite
DDI	Daini Denden Inc
IDC	International Digital Communications
IPTP	Institute for Posts and Telecommunications Policy
ITJ	International Telecom Japan
JATE	Japan Appovals Institute for Telecommunications Equipment
JKC	Japan Keytech Centre
JSB	Japan Satellite Broadcasting
KDD	Kokusai Denshin Denwa Co Ltd
LCV	Lake-CityCable Vision
MPT	Ministry of Posts and Telecommunications
MITI	Ministry of International Trade and Industry
NAB	Natl. Assoc. of Commercial Broadcasters
NCCs	New Common Carriers
NHK	Nippon Hoso Kyokai (Japan Broadcasting Corp.)
NNS	Nippon Network Service
NTT	Nippon Telegraph and Telephone
RCR	Research and Development Center for Radio Systems
SDAP	Satellite Digital Audio Broadcasting
TAO	Telecommunications Advancement Organization of Japan
TC	Telecommunications
TCV	Tokyo Cablevision
TTC	TC Technology Committee (wired comm.)
TTN	Tokyo Tsushin Network

Figure 2: Structure of the planned Japanese info-communications infrastructure

Infrastructure		Implications	Social requirement
Value Legal framework	Level 4	Lifestyles Workstyles	- Reforming personal values and the socioeconomic system
Informatization of education, medical care, government services (Contents)	Level 3 (relevant industry)	Application databases, Applications	- Developing creative technologies - Making public services more efficient - Diversifying applications
Information circulation system (Platform)	Level 2 (Type 2 business)	Information processing and transceiving devices, etc.	- Diversifying and enhancing functions
Information transmission system (Distribution)	Level 1 (Type 1 business)	Physical transmission media	- Stable supply - Fair use - Affordable tariffs

Source: Telecommunications Council 1994, p 2; MPT 1995, p 25.

Table 3: The use of info-communications in the US and Japan

	USA	Japan
% of personal computer linked to local area networks	52.0 %	8.6 %
Penetration of personal computers	15.8 %	5.7 %
Data base market; in billions of yens	1,276	216
Number of CD-ROM titles	4,000*	1,000*
Cable TV operators	11,075	149**
Cable TV subscribers; in million	57.21	1.08**

Source: MPT, cited in Nikkei Weekly, 16 May 1994

* Approximate

** urban-type CATV only

A STRATEGIC PLAN FOR BUILDING AN INFORMATION INFRASTRUCTURE: A CASE FOR THE U.S. DEPARTMENT OF TREASURY

Tom McKeown
President, Vista Group International
Vienna, Virginia

Ken Malley
U.S. Department of Treasury
Washington, D.C.

1. ABSTRACT

This paper describes the drivers and trends, the process and results of a one-year effort to create, on a team basis, a comprehensive Strategic Plan for building an Information Infrastructure for the U.S. Department of Treasury. Since Treasury is one of the largest and most vital of all U.S. Government agencies, the Treasury Information Infrastructure will be a major component of the Global Information Infrastructure and the U.S. National Information Infrastructure.

2. INTRODUCTION

The U.S. Treasury Department is a collection of eleven major bureaus and sub-agencies with diverse missions and responsibilities. Responsibilities of the Treasury revolve around: collection and payment of revenue, production of moneys, international trade, law enforcement, total government financial accounting, and, of course, protection of the president and the currency. Thus, the strategic planning process took on a significant challenge for creating team consensus in building a common, shared Information Infrastructure. Its realization will require organizational perspectives with improved services to U.S. citizens as the major thrust. The strategic blueprint contained herein describes the corporate visions of future capabilities and innovations that will position Treasury to be a key conduit and public sector contributor in the National Information Infrastructure (NII).

3. THE SITUATION

During 1994 and 1995, the Treasury Department was preparing to award a major contract (estimated at nearly $1billion) for the procurement of a follow-on network to their existing Consolidated Data Network (CDN). As indicated in Figure 1, CDN's robust telecommunications infrastructure makes available a range of technology that reflects the diverse business needs of its users. The follow-on procurement for a "Treasury Communications System (TCS)" was to build on the robust CDN connectivity and add multi-dimensional information services. The expanded CDN telecommunications capabilities (the new TCS) combined with networked based computing services eventually defined the Information Infrastructure. It is important to note that the TCS Request for Proposal (RFP) was a functional specification; it did not specify technical and product solutions.

4. AN ERUPTIVE TELECOMMUNICATIONS ENVIRONMENT

The radical shifts in the telecommunications industry in the U.S. and in other parts of the world will significantly affect all governments. Rapid privatization, deregulation, dissolution of the U.S. Regional Bell Operating Company's boundaries, the rise of the "bypass providers", the introduction of CATV into the telecomm market, the explosive growth and popularity of the Internet, and the astounding pace of technological change are just some of the major ingredients reshaping the industry. On top of this, the role of the network is changing. It is the network, not the data center, which is becoming the enterprise's key, centrally managed, IT resource. As network-based, distributed applications emerge and the boundaries between computing and telecommunications disappear, the Information Infrastructure is being born.

5. THE TREASURY COMMUNICATIONS SYSTEM (TCS) OPERATING ENVIRONMENT

The TCS must be flexible and dynamic to accommodate redefined business requirements and allow Treasury to harness new technologies as they become available. Some of the changes in the operating environment include increasing demand for interoperable systems, expanded use of client/server applications, the rapid growth of electronic messaging and wireless systems. See Figure 2. Collaborative software and gains in group

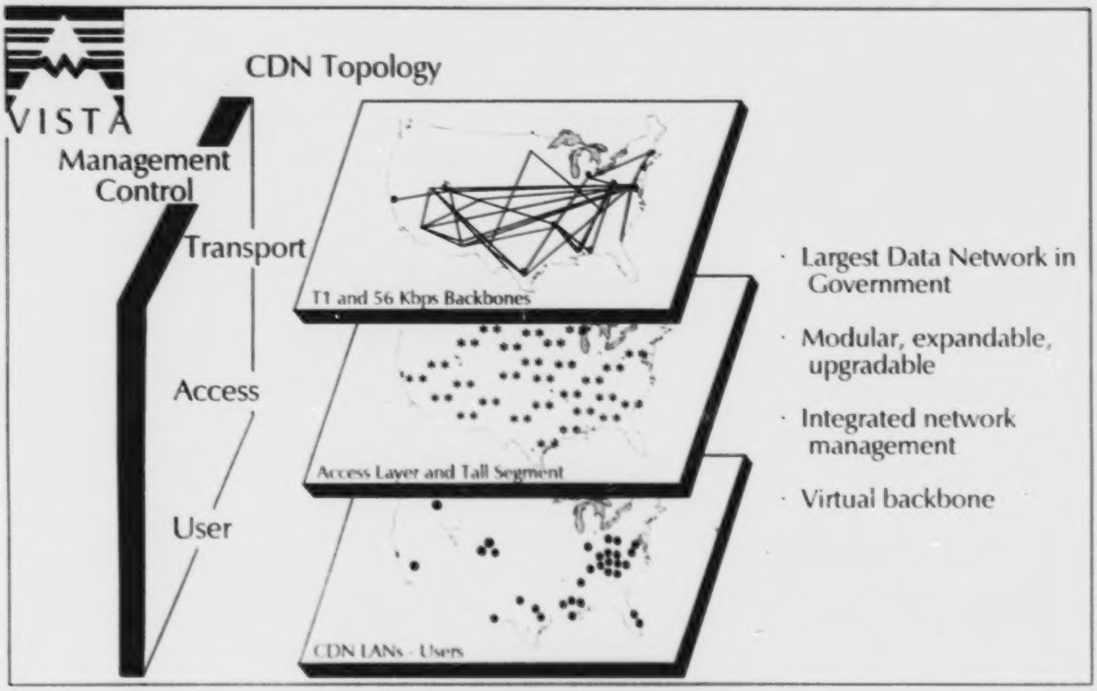

VISTA
CDN Topology
Management Control
Transport
Access
User
T1 and 56 Kbps Backbones
Access Layer and Tail Segment
CDN LANs - Users
· Largest Data Network in Government
· Modular, expandable, upgradable
· Integrated network management
· Virtual backbone

FIGURE 1. TELECOMMUNICATIONS INFRASTRUCTURE
CDN COMMUNICATIONS SYSTEM

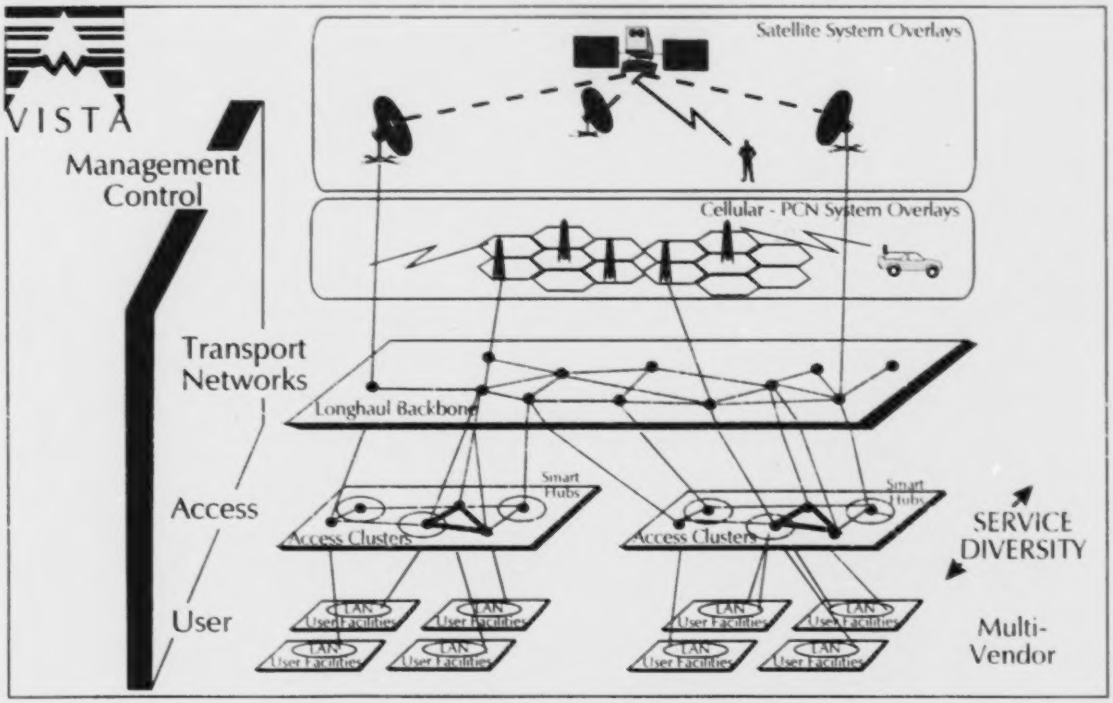

VISTA
Management Control
Satellite System Overlays
Cellular - PCN System Overlays
Transport Networks
Longhaul Backbone
Access
Smart Hubs
Access Clusters
Smart Hubs
Access Clusters
SERVICE DIVERSITY
User
LAN
User Facilities
Multi-Vendor

FIGURE 2. TELECOMMUNICATIONS INFRASTRUCTURE
TREASURY COMMUNICATIONS SYSTEM

productivity through workflow processing are expanding in the areas of accounts processing, law enforcement and telecommuting. In addition, workers are placing more reliance on laptops and hand-held computers to access distant information sources to perform their jobs. Speaking on the changes in communications, Vice President Gore has said, "This Administration intends to create an environment that stimulates a private system of free-flowing information conduits." In order to achieve this, the National Performance Review identified the Department of Treasury TCS as a major component of the National Information Infrastructure, and a key enabler for the reengineering of government business processes.

6. GOVERNMENT TRENDS AND DRIVERS

There is unprecedented change taking place in every facet of Federal Government business and its pace is intensifying. Government political initiatives for the application of information technology (IT), and rapidly advancing technology, are driving major changes in the way government business is performed. Presidential mandates for Government-wide electronic mail, electronic commerce and better access to government information and services for citizens are just a few of the directions for change. Others, such as the need for multimedia, video conferencing, imaging and telecommuting are additional capabilities being identified by users. Alternative ways of filing for U.S. taxpayers and fiscal realities are restructuring and eliminating organizations and even entire Departments. These technical and organizational changes coupled with government and citizen demands for more information services, have set in place the foundation for the Government Services Information Infrastructure (GSII).

7. GOVERNMENT SERVICES INFORMATION INFRASTRUCTURE (GSII)

The Vice President of the U.S. endorsed the creation of a Government Services Information Infrastructure (GSII), and a Government Information Technology Services (GITS) Working Group, to coordinate government efforts to improve the application of information technology by all government agencies. The "Reengineering of Government Through Information Technology". The key objectives of the GITS Working Group are:

a. Provide a clear, strong leadership to integrate technology into the business of government.

b. Implement Nationwide Integrated Electronics Benefits Transfer.

c. Develop Integrated Electronic Access to government information services.

d. Establish a National Law Enforcement/Public Safety Network.

e. Provide Intergovernmental Tax Filing, Reporting, and Payments Processing.

f. Establish an International Trade Data System.

g. Create a National Environmental Data Index.

h. Plan, demonstrate and provide Government-wide Electronic Mail.

i. Establish an Information Infrastructure.

j Develop systems and mechanisms to ensure privacy and security.

k. Improve methods of Information Technology acquisition.

8. THE NATIONAL INFORMATION INFRASTRUCTURE (NII)

The White House formed an Information Infrastructure Task Force (IITF) to articulate and implement policies and initiatives to accelerate deployment of the National Information Infrastructure (NII). Government and industry are participating in the development of networks and services to be offered to the public for the good of the nation. Government is providing leadership and limited funds for research, while industry is building the infrastructure.

9. THE GLOBAL INFORMATION INFRASTRUCTURE (GII)

The nations of the Group of Seven (G7) and others throughout the world, have begun implementing an initiative developed by the United Kingdom to coordinate and share the building of a Global Information Infrastructure. The U.S. Government has appointed the Chairperson of the GITS Working Group to be the U.S. representative. This has significant implications for all governments since government activity will enjoin an international perspective more than ever before. The fact that the world's leading industrialized nations have decided to share expertise and collaborate on pilot projects that would accelerate public access to government services and information, offers an unprecedented opportunity to the citizens of the world and the providers of Information Technology products and services. See Figure 3.

10. FEDERAL, STATE AND LOCAL INTERGOVERNMENTAL INITIATIVES

A unified financial information infrastructure between the states and the federal government is being planned which would minimize the burden on employers and employees by consolidating tax and wage reporting systems. The Simplified Tax and Wage Reporting System (STAWRS) will create a central financial information service center that will make updated employee information available to all authorized government organizations. A plethora of Intra/Intergovernmental Financial Network Services is being planned. By combining innovative information processing techniques and telecommunications, the enforcement community also is seeking to prevent and combat the increasing number and complexity of crimes with which all levels of government must contend. These and other intergovernmental activities will have a profound effect on internetworking and interoperability demands for standards and common products for multi-service backbone networks.

11. MANAGING CHANGE BY STRATEGIC THINKING AND PLANNING

With technology changing so rapidly, and the government procurement process often too ponderous to specify technical solutions to tomorrow's needs, a planning method for managing change was critical. In addition to planning for technology transition, and creating consensus among the different sub-agencies and bureaus of Treasury, the primary purpose of the Strategic Planning Project was to develop strategies for managing change in a proactive manner. The multistage strategic planning process used for this project will probably continue on an iterative basis throughout the life of the Government Information Infrastructure. Defining infrastructure according to strategic directions, and with a team thinking strategically rather than choosing or guessing at technology, offered maximum flexibility for solutions to user's requirements.

12. THE CHALLENGE

In addition to accommodating political, technical and operational changes in the environment, the building foundation for this Information Infrastructure had to support the many varied missions of diverse government agencies. For example, the Bureau of Engraving and Printing (BEP) is highly production-oriented and needs coordination among its locations. BEP requirements for interfacing with other agencies are intermittent. The U.S. Customs Service (USCS), on the other hand, depends on accurate information and constant interaction with outside organizations in conjunction with trade monitoring and enforcement activities. USCS is charged with maintaining an International Trade Database. Enforcement activities, such as those undertaken by USCS, the U.S. Secret Service (USSS), and the Bureau of Alcohol, Tobacco, and Firearms (ATF) rely on sharing information within Treasury and with other Government networks, such as the Defense Information Systems Network (DISN). Users also have different imbedded technological bases that challange interoperability.

13. THE STRATEGIC PLANNING PROCESS

The Information Infrastructure Strategic Planning project was the result of following a proven process that was developed and coordinated by Vista Group International. Figure 4, "Strategic Planning Process Cycle", illustrates the major steps followed.

14. CORPORATE GOALS ARE TRANSFORMED INTO VISIONS BY STRATEGIC PLANNING CORE TEAM

A Core Team of key personnel and alternates from each of the bureaus of the Treasury Department was formed. The Core Team researched and identified the key information technology capabilities, in functional terms, required to support corporate mission statements, business plans, Information System Plans, and other Treasury organizational mandates. From these, the Core Team identified over 25 visions for the Information Infrastructure, which were later consolidated into a set of 12 corporate visions. See Figure 5.

15. IDENTIFYING THE ISSUES

The Core Team identified issues that reflected the challenges, obstacles and concerns to be addressed in achieving each vision. Issues have significance on a number of different dimensions, such as policy, technology, organization, operations, cost and culture. Information about issues was gathered through a data collection process and industry research. Users and executives were interviewed to gain their insight, acting as a reality check to business plans objectives.

16. DEVELOPING STRATEGIC DIRECTIONS

Strategic Directions consist of actions and decisions necessary to realize the Visions and resolve the Issues. The model for developing Strategic Directions, see

499

Figure 6, underscores the need for constant assessment when planning a system that will change over time, as it responds to a dynamic technical and business environment. A Strategic Direction may be composed of several supporting activities that require detailed, multi-stage implementation activities.

17. ADDRESSING IMPLEMENTATION CONSIDERATIONS

Implementation considerations were addressed within the context of the Strategic Directions. These considerations discuss some of the realistic constraints on action, and serve to qualify expectations concerning the feasibility of various Strategic Directions and their likely consequences in terms of time and resource requirements.

18. MEASURING ACCOMPLISHMENTS

Each strategic direction, as related to the accomplishments of a vision, will require periodic performance measurement. The timing of implementation recognizes evolving capabilities, and some strategies must wait for others to begin. For example, pilot projects being conducted will be monitored, documented, and the results transferred to the planning team. In any event, periodic assessments by management and user groups must be conducted to determine progress, problems, and value.

19. THE CORPORATE VISIONS AND KEY STRATEGIES

The following paragraphs describe the Corporate (meaning consensus within Treasury) Visions or capabilities derived by the Core Team. The Key Strategies associated with each Vision are the Strategic Directions decided upon in order to achieve the Visions.

19.1 ELECTRONIC COMMERCE SERVICES

VISION STATEMENT

Electronic Commerce Services offer an integrated set of capabilities that users may adapt to reengineer acquisition, payment, and tax-related business processes, thereby increasing productivity, reducing paperwork, and saving time in transacting business with trading partners.

The President's plan for Electronic Commerce calls for all Federal agencies and vendors to process solicitations, purchase orders, invoices, contract amendments, and payments on a government-wide Electronic Data Interchange (EDI) system.

KEY STRATEGIES

- Build Electronic Commerce capabilities that will enable Treasury and other designated government agencies to reengineer business processes.

- Take a leadership role in Electronic Commerce development within government.

19.2 ELECTRONIC MESSAGING SERVICES

VISION STATEMENT

Electronic Messaging Services will build the essential infrastructure to link all Treasury users, creating communications media that exemplify the Electronic Government

The provision of Electronic Messaging Services answers the Federal mandate to implement government-wide e-mail.

KEY STRATEGIES

- Establish messaging standards for the TCS that are consistent with U.S. and international commercial practices. The recommended standards today include the most widely accepted X.500, 1988 X.400, and Internet Mail (Simple Mail Transfer Protocol/ Multipurpose Internet Mail Extension [SMTP/MIME]).

- Enable a protected and highly secure access to Internet, World-wide Web, and bulletin board/kiosk information resources.

- Establish e-mail Conversion Services that will convert facsimile and other media to E-mail and allow communication between disparate e-mail systems.

19.3 INTER-NETWORKING SERVICES

VISION STATEMENT

Through Internetworking Services, users will freely interoperate with multi-protocol networks and applications, taking full advantage of information resources available through the National and Government Services Information Infrastructures.

Internetworking Services will allow the creation of virtual agencies based on different missions but sharing a common information infrastructure.

KEY STRATEGIES

- Take an incremental approach to change. Promote connection to the network first, then migrate groups to an interoperable suite of products.

- Set clear and unequivocal policy directions on standards so that information system changes made are consistent with the standard. Avoid the temptation to grant waivers to the standard but do not force costly preemptive conversions.

- Define critical networks outside Treasury to which connectivity is required.

19.4 SECURITY SERVICES

VISION STATEMENT

The integrity, confidentiality, and availability of the Information Infrastructure and those resources, products, and activities encompassed within, will be ensured with full accountability.

Marketplace trends show increasing recognition that encryption and authentication mechanisms, such as digital signature, are necessary to reduce vulnerabilities.

KEY STRATEGIES

- Establish a common organization responsible for the oversight. This should include training, risk assessments, and certification authorizations.

- Formulate policies for Security Services. Such policies would offer user organizations electronic key distribution, firewall implementations, and special auditing services.

19.5 NETWORK MANAGEMENT AND CONTROL SERVICES

VISION STATEMENT

Users will benefit from pro-active problem isolation, diagnostics, and dynamic reconfiguration as Network Management and Control Services allow a composite view of the entire system, with segmented domain administration and service privileges as required by individual agencies.

KEY STRATEGIES

- Adopt a hierarchical multi-domain network management system based on an Open Management Platform Architecture. This architecture could allow connection to independent local management consoles and the use of SNMP to all devices and carrier management services. Migrate the entire enterprise to a single network management platform standard.

- Implement end-to-end network management oversight, while recognizing the need to segment site level operations/management domains in response to an organization's security and business needs.

19.6 INTRA/INTERGOVERNMENTAL FINANCIAL NETWORK SERVICES

VISION STATEMENT

Treasury will enhance its leadership role in the virtual networks created by local, State, and Federal government entities by using Intra/Intergovernment Financial Network Services to electronically deliver benefits, process tax- and duty-related information, and coordinate a full range of banking activities.

Treasury will develop Intra/Intergovernmental Financial Network Services to further support the electronic exchange of financial transactions and information.

KEY STRATEGIES

- Establish a Treasury-wide Financial Network User Group. Evaluate, in particular, the Simplified Tax and Wage Reporting System as an example of intra/interorganization cooperation.

- Select the initiatives within the commercial EDI conventions relating to financial transactions that could be incorporated.

- Establish standard procedures and processes for using technology for financial applications.

19.7 MULTIMEDIA/VIDEOCONFERENCING/ BROADCAST SERVICES

VISION STATEMENT

Users will select convenient desktop and group alternatives for information exchange, conferencing, and training, by selecting from an extensive array of state-of-the-art technologies, available through Multimedia/Video Conferencing/Broadcasting Services.

Multimedia/Video Conferencing Broadcast Services should follow user applications. Operational efficiencies, economies of scale, and management control can be improved through the use of consolidated services.

KEY STRATEGIES

- Establish a Treasury-wide Multimedia/Video Conferencing/Broadcast Services Working Group.

- Leverage Treasury's visibility to form government/ industry strategic alliances to develop alternatives for major applications as part of a standards development process.

19.8 NETWORK-BASED COMPUTING SERVICES

VISION STATEMENT

Network-based Computing Services will empower users with privileged access to a menu of information and computing resources.

Users will realize information management efficiencies by centralizing network-based computing resources. For users, this set of capabilities will establish the Information Infrastructure paradigm as a service-based utility.

KEY STRATEGIES

- Establish Treasury Information Services Center(s) (TISCs) that will integrate management of TCS network-based computing resources, transmission connectivity, and security and network management.
- Incorporate several Network-based Computing Services by identifying and implementing service offerings that are applicable to most agencies, such as public access to government information, training, and telecommuting.

19.9 PUBLIC ACCESS TO GOVERNMENT INFORMATION SERVICES

VISION STATEMENT

Users will respond to the American public's desire and need for user-friendly, accurate, and confidential Public Access to Government Information Services by using different combinations of service capabilities.

Public Access to Government Information and Services will support the "outreach" aspect of an Electronic Government, to better serve the U.S. citizen and disseminate information more easily and efficiently, using a variety of communications media.

KEY STRATEGIES

- Sponsor an inter-bureau initiative to assess the feasibility of, and formulate an approach to, using a single mechanism for implementing multiple access methods for the public to obtain information.
- Establish the Internet and World-wide Web (WWW) as two primary methods of supporting public access to government information.
- Provide 800 services, kiosks, and bulletin board access as required.

19.10 INTRA/INTERGOVERNMENT ENFORCEMENT NETWORK SERVICES

VISION STATEMENT

Intra/Intergovernment Enforcement/Network Services will leverage the best available information technologies to coordinate and achieve successful investigative and enforcement activities at all levels, including international.

These services are essential for meeting mission enforcement objectives in a cost-effective manner. Users whose missions involve enforcement activities will benefit from services that enable coordination with local, State, Federal, and international organizations.

KEY STRATEGIES

- Establish a Treasury Intra/Intergovernment Enforcement Network Group to identify the required information, databases, and desired product of an integrated Information Infrastructure for enforcement and investigative purposes.
- Partition into subnetworks to accommodate the special needs of the enforcement community. The partition must be able to support control, and wireless communications.

19.11 WIRELESS COMMUNICATIONS SERVICES

VISION STATEMENT

Users will require interoperable, transparent, and secure Wireless Communications Services to pursue corporate objectives regardless of geographical location, mobility, natural disaster and emergency conditions.

Wireless Communications Services will facilitate remote access to data, voice, messaging, and extended LAN capabilities. Wireless capabilities are critical to personnel, even to their survival, during enforcement activities.

KEY STRATEGIES

- Maintain the focused approach initiated in 1991 for Wireless/Radio Service and Support (WRSS) with the continued involvement of the Federal Law Enforcement Wireless Users Group (FLEWUG). Standard commercial techniques for data access should be incorporated for message traffic, such as those being developed in the Project-25/ Telecommunications Industry Association (TIA) groups for the next generation digital public safety radio

19.12 TELECOMMUTING SUPPORT SERVICES

VISION STATEMENT
Telecommuting Support Services will promote and support collaborative work efforts by linking users at dispersed locations, thus increasing productivity, saving space, maintaining essential business services under exceptional circumstances, and encouraging employment of individuals covered under the Americans with Disabilities Act.

Telecommuting Support Services will offer a solution to environmental, socio-cultural, and business continuance issues that revolve around establishing alternative work sites.

KEY STRATEGIES

- Establish a TCS Telecommuting Group to identify and justify pilot projects.
- Define a TCS telecommuting support infrastructure to determine requirements for automated information resources at alternative work sites. Include plans for leveraging desktop video conferencing.

20. TREASURY INFORMATION SERVICE CENTER(S) (TISCs)

The Core Team paradigm—the concept of using the network to operate a variety of network-based computing services—developed a concept for an Information Services Center. The benefits to be derived from this model include improved interfaces, enhanced security, increased productivity, uniform addressing and routing, quick problem resolution, and synchronization of databases. An initial TISC will be located with the TCC in order to maximize service quality, minimize expenditures, and to integrate management and control resources. See Figure 7.

21. CUSTOMER ACTION TEAMS GUIDE IMPLEMENTATION OF VISIONS

The building of an Information Infrastructure will require more in active coordination and cooperation among its users than would normally be required for just a network or a few information systems. By combining telecommunications, using all the media, with information services and systems mostly imbedded in the network with servers, the building blocks become very complex, at the least. Treasury has decided to establish Customer Action Teams, composed of its business customers, operators and IT specialists, who will act as "customer oriented" oversight "learning organizations." There will be a Customer Action Team for each Vision area whose members will seek and recommend new technology, pilot programs, changes to services, and will appraise and measure the progress of implementation.

22. SUMMARY

The use of a Strategic Planning Process, while based on a considerable amount of information and analysis, is the most effective method to address, and attempt to manage, a rapidly changing business, culture, and technical environment. Over time, Visions will remain mostly constant, while the Issues and Strategic Directions will not. The goal of the strategic planning effort is to fix a blueprint for the gradual realization of capabilities and end states in space and time, while establishing processes for flexible response and reevaluation.

To ensure the attainment of the benefits derived from the Strategic Planning Process, a commitment must be made to establish a permanent Core Team. This group of dedicated professionals, with both management and technical skills, will continue an iterative process of focusing resources strategically in response to requirements or Customer Action Teams, with the caveat that measuring the accomplishment of a Vision is but a step in a continuing journey.

REFERENCES

(1) Herman, James; "The Role of the Network is Changing," Northeast Consulting Inc., March 15, 1994.

(2) National Performance Review; "Creating A Government That Works Better and Costs Less," September 7, 1993.

(3) Blum & Litwack; "The E-Mail Frontier," Copyright January 1995.

(4) "Realizing The Information Future," National Research Council, National Academy Press, 1994.

(5) Drucker, Peter; "Managing for the Future," November 1993.

(6) Naisbitt, John; "Global Paradox," January 1995.

(7) Joseph A. Pecar, Roger J. O'Connor, David A. Garbin; "Telecommunications Fact Book," January 1993.

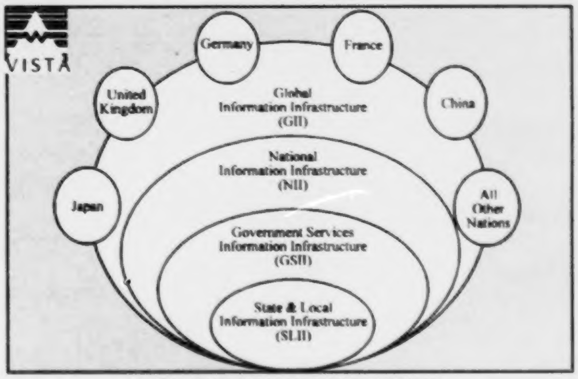

VISTA
Germany
France
United Kingdom
China
Japan
All Other Nations
Global Information Infrastructure (GII)
National Information Infrastructure (NII)
Government Services Information Infrastructure (GSII)
State & Local Information Infrastructure (SLII)

FIGURE 3 RELATING ALL GOVERNMENT INFRASTRUCTURES

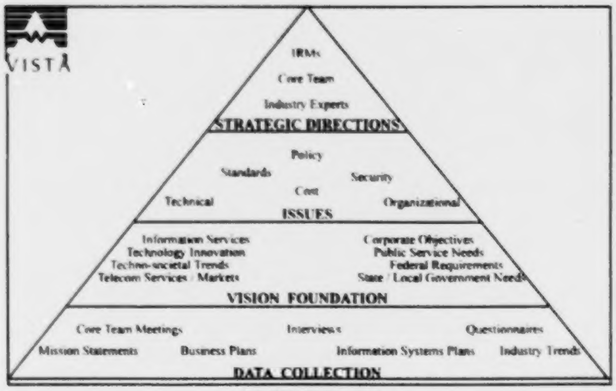

VISTA
IRMs
Core Team
Industry Experts
STRATEGIC DIRECTIONS
Policy
Standards
Security
Cost
Technical
Organizational
ISSUES
Information Services
Technology Innovation
Techno-societal Trends
Telecom Services / Markets
Corporate Objectives
Public Service Needs
Federal Requirements
State / Local Government Needs
VISION FOUNDATION
Core Team Meetings
Interviews
Questionnaires
Mission Statements
Business Plans
Information Systems Plans
Industry Trends
DATA COLLECTION

FIGURE 6 FOUR PHASES

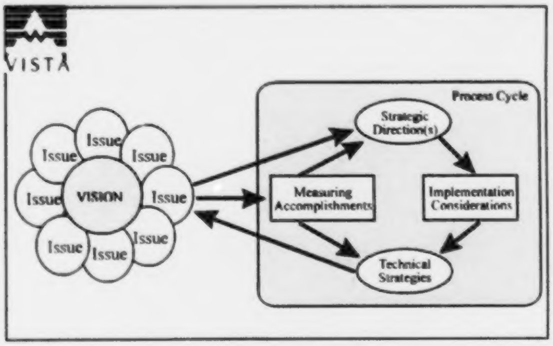

VISTA
Issue
Issue
Issue
Issue
VISION
Issue
Issue
Issue
Issue
Process Cycle
Strategic Direction(s)
Measuring Accomplishments
Implementation Considerations
Technical Strategies

FIGURE 4 STRATEGIC PLANNING PROCESS CYCLE

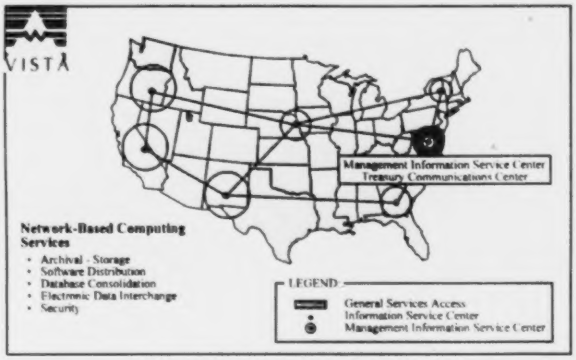

VISTA
Management Information Service Center
Treasury Communications Center
Network-Based Computing Services
• Archival - Storage
• Software Distribution
• Database Consolidation
• Electronic Data Interchange
• Security
LEGEND
General Services Access
Information Service Center
Management Information Service Center

FIGURE 7 TREASURY INFORMATION SERVICE CENTERS

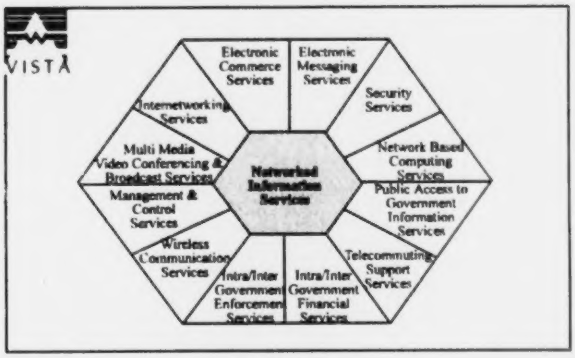

VISTA
Networked Information Services
Electronic Commerce Services
Electronic Messaging Services
Security Services
Network Based Computing Services
Public Access to Government Information Services
Telecommuting Support Services
Intra/Inter Government Financial Services
Intra/Inter Government Enforcement Services
Wireless Communication Services
Management & Control Services
Multi Media Video Conferencing & Broadcast Services
Internetworking Services

FIGURE 5 VISIONS

National Information Infrastructure Policies in an Era of Global Networks

Johannes M. Bauer
Michigan State University
East Lansing, Michigan, USA

1. ABSTRACT

The paper examines the effects of the liberalization of international capital flows and the emergence of globally operating telecommunications service providers on the design and implementation of national information infrastructure policies. Compared to the recent past, during which most service providers operated on a predominantly national basis, in the era of global networks the options for national policies are broadened in some areas but constrained in other areas.

2. INTRODUCTION

There is broad agreement that an appropriate information infrastructure is an important national (and international) asset. Considerable discrepancies, however, exist between the participants in the public policy debate as to the best approach to achieve such an infrastructure. Policy prescriptions and concrete public policies fall in a spectrum ranging from laissez-faire positions to proposals for a more centralized deployment of advanced infrastructures. In spite of the fact that main players in the telecommunications industry do not any more operate predominantly on a national basis but have begun to pursue international opportunities, the implications of this fundamental structural change on the power of national institutions to design and effectively implement national policies has not yet been examined.

In this paper, I will discuss these issues from the perspective of national economies at different stages of their development. In the next section of the paper I will briefly review the traditional approach to infrastructure policy. In the third section, I will review the effects of the globalization of main parts of the telecommunications industry on national policy design. Section four discusses in more detail policies for the new environment that address the institutional framework of the industry and policies that affect the conduct of main players in the industry. The final section of the paper presents the main conclusions and thoughts for further research(1).

3. INFRASTRUCTURE POLICY IN CLOSED ECONOMIES

Until about a decade ago, telecommunications service providers operated essentially in closed economies, that is, in an institutional framework that permitted only relatively limited flows of capital across national borders. In this situation, national information infrastructure policy could rely on a broad spectrum of options to influence the behavior of telecommunication service providers and thus the speed and direction of national infrastructure development. National policies were designed to overcome particular policy problems (market failure, government failure) associated with telecommunications depending on the existing policy framework (public ownership, private ownership, etc.).

Frequently, the main problem of national infrastructure policy was identified as insufficient investment. A proper response to this gap was seen in policies that would induce operators to increase investment into infrastructure, such as the granting of tax breaks, subsidies, or the permission to use internal subsidies to expand networks and services.

However, lacking investment is only one of the many aspects of potential information infrastructure policy issues. Other related issues include a suboptimal quality of the information infrastructure, an insufficient rate of infrastructure modernization, a fragmentation of the networks and services constituting the information infrastructure, limited access, or an overall weak performance of the sector, quasi compound evidence of all the other aspects.

In an era of increasingly open national infrastructure markets and globally operating telecommunications service providers, the available policy-options differ from a situation in which markets were closed and telecommunications service providers were organized as territorial franchisees (see table 1). On one hand, national options are *expanded*, for instance, by improved access to international capital markets, technology, and expertise.

Table 1
INFRASTRUCTURE POLICY OPTIONS IN CLOSED AND OPEN ECONOMIES

	Closed Economies		**Open Economies**	
	Options	Constraints	Additional Options	Additional Constraints
Conduct-Oriented Policies	• Tax incentives to stimulate infrastructure investment. • Subsidies. • Cross-subsidies. • Infrastructure surcharge. • Technology policy.	• Profitability of other national investment projects. • Competing uses for taxes. • Domestic supply and demand-side conditions. • Tax resistance. • National technological and R&D resources.	• Access to international capital markets. • Access to technology and expertise that would not be licensed.	• Risk/return profile of domestic projects compatible with international investment options. • Reduced effectiveness of policies that attempt to influence the return on infrastructure investment.
Structural Policies	• Infrastructure planning. • Establishment of efficient institutional and regulatory framework. • Pro-competitive policies. • Privatization and reorganization.	• Existing legal and policy framework.	• International alliances and agreements to support domestic infrastructure development.	• International "convergence" of policy approaches reduces spectrum of feasible national options.

On the other hand, the increased mobility of capital and the emergence of investment opportunities may create new *constraints* that did not exist in nationally closed market environments. For example, firms seeking the most profitable investment opportunities may decide to disinvest in a certain country or to negotiate rather favorable conditions for their operations, such as long-term exclusive franchises, if foreign investment projects are available that promise a significantly higher return on equity. Such strategies may have detrimental local welfare effects and may constrain the ability of national institutions to shape national infrastructure policies.

National authorities will thus have to adopt policies that will make investment by a domestic (or foreign) firm attractive within the spectrum of international investment opportunities. Traditional information infrastructure policies, as they are pursued by nations and states within nations, frequently only consider the national framework. Hence they may be of little influence on the investment activities of major operators that select investment opportunities on a global basis. Such traditional policies include conduct-oriented measures such as tax credits for telecommunications investment, subsidies, etc. (However, such policies may well remain an effective tool for companies with only a national horizon for their investment projects. Also, they may remain effective once a firm has begun to invest into local facilities because of the immobility created by sunk costs.) The "mix" of infrastructure policies thus will need to be adjusted to this new freedom of carriers to chose investment projects on a global scale. We will turn to this issue in the next section.

4. INFRASTRUCTURE POLICY OPTIONS IN OPEN ECONOMIES

The patterns of telecommunications investment and of related technology transfer have changed significantly during the past decade as more and more countries have opened their national markets for investment by foreign service providers. The largest telecommunications service providers and many new start up companies have begun to re-orient their investment portfolio towards international activities, in part substituting foreign investment for domestic investment projects (Azoulay, 1995; Bauer, 1995c; Ruhle, 1995). The main flows of capital take place between countries in the OECD, especially between the U.S., Europe and the Pacific Rim; between industrialized countries and the growth areas in Asia and South America; and to a somewhat lesser degree between industrialized countries and selected countries in the former communist bloc. Comparatively low amounts of capital are targeted to the Middle East as well as Africa. To understand and assess the potential effects of capital mobility on national infrastructure policy options better, it is useful to review the foreign investment decision-making processes of main providers of telecommunications services.

Contrary to a situation of territorially bound telecommunications service providers, in an internationally open environment, firms with sufficient capital and expertise will evaluate foreign projects in addition to domestic investment opportunities. The choice set of projects is expanded to $I = I(P_1^1, P_2^1, P_3^1, ..., P_n^1; ....., P_1^k, P_2^k, P_3^k, ... P_n^k)$, $i = 1, ..., n$ denoting different projects in countries $j = 1, ..., k$. An optimal investment portfolio will be selected from this expanded set of opportunities such that $\Pi(I) = \Sigma_{i,j} \Pi(P_{i,j})$ is maximized (Bauer, 1994). In shaping their decision as to whether to invest into domestic projects, foreign projects, or retain the option to invest at a later point in time when more information is available on the potential investment projects, firms will consider their organizational strengths, their competitive position in the home and host markets, the advantages of being a first mover, the advantages of foreign direct investment versus licensing, and the option value of waiting. In general terms, a firm will typically decide to invest in a project if the expected profit from the project exceeds the return of a risk-free alternative by a certain threshold. The higher the degree of uncertainty, the higher the value of waiting and vice versa. In addition, the extent of sunk costs will influence the decision to invest (Dixit & Pindyck, 1993). In the case of infrastructure investment, the degree of uncertainty is influenced by the stability of the institutional and legal framework of the industry in the host country, the expectations as to the future economic development of the country, the ability to repatriate profits, and so forth.

The firm will, further, have to assess the different organizational forms such a foreign venture could take. These include foreign direct investment (FDI) in a stand-alone project, FDI in a joint venture, the formation of an alliance with a local partner, the licensing of technology and expertise, or the exportation of goods or services. This decision will, to a large degree, be based on the character of the good or service provided. Some services, like a telephone call, typically cannot be exported but need a local presence. If such a local presence is not required, the optimal decision will depend on whether or not the information necessary to provide a service can easily be imitated. If this is the case, that is, if a potential licensee could reproduce the service easily, firms will typically be reluctant to sell a license or even enter a joint venture. Instead, they will try to internalize operations through foreign direct investment. If the specific market is closed to FDI, they will not engage in any transactions at all (Dunning, 1981).

4. IMPLEMENTATION OF STRUCTURAL AND CONDUCT-ORIENTED POLICIES

Information infrastructure policies typically fall into the two categories of policies that affect the legal and institutional framework of the industry ("structural" measures, for instance, the degree of liberalization of a submarket of telecommunications) and policies that affect the processes of entrepreneurial decision-making within those structures ("conduct-oriented" measures). In an era of global networks, the influence of national promotional conduct-oriented policies tends to be weakened whereas structural measures gain in importance.

4.1 CONDUCT-ORIENTED POLICIES FOR OPEN ECONOMIES

Conduct-oriented policies attempt to provide incentives for the players in the telecommunication area to behave according to infrastructure goals. Many of the traditional approaches to influence the level of the structure of infrastructure investment fall into this category. They include tax incentives for increased investment, forms of subsidies, or other forms of public policies to induce investment into information infrastructure, such as waivers of fees for rights of way. They also include the adoption of regulatory instruments that are perceived to stimulate infrastructure investment. Such approaches have been widely used in North America, where the main providers of telecommunications infrastructure are privately owned and public policy needs to rely on indirect mechanisms to influence the decision-making of the private industry. Last, but not least, they also include more discretionary policies, such as the inclusion of obligations to provide service to poor regions or low income customers, into an operating license granted to a telecommunications service provider; regional or temporary public investment programs; partnerships between public and private sector institutions to deploy information technologies to schools and hospitals; and so forth.

In the U.S., examples for programs that attempt to influence to return on capital on telecommunications investment include the subsidies directed to small and rural telephone companies through the historical pooling arrangements, low interest loans through the Rural Electrification Administration (REA) program for telephone companies, or tax incentives included in the Economic Recovery Act of 1984. Similar programs have been established by the European Union, As has been the case for many other programs to stimulate investment, the effect of these programs has been questioned on theoretical and empirical grounds (Dixit & Pindyck, 1993; Fuhr, 1990; Gramlich, 1994). More recently, cities and municipalities have become proactive in encouraging the accelerated development of local information infrastructures leveraging their control over rights of way. Examples include the request for proposals to develop an advanced information infrastructure for the city of Seattle and initiatives of many communities across, but also outside of, the U.S. (Graham & Simon, 1994).

Several authors have argued that the system of rate-base/rate-of-return regulation also has provided incentives to invest into facilities because these would enter the rate base and thus become eligible to earn a fair rate of return (Trebing, 1994). However, these arguments have never been empirically substantiated. Furthermore, as software, which is typically expensed and not put into the rate-base, becomes an increasingly important part of the information infrastructure, this stated incentive will likely decline. More recently, many U.S. jurisdictions have introduced price-cap regulation and other types of incentive regulation to stimulate investment and innovation into information infrastructure. In concept, such regulatory tools will be able to stimulate types of investment and innovation that will increase the profitability of the regulated service provider. In general, incentives will be stronger for process innovations (e.g., digital switching equipment, SS7, fiber optic transmission and distribution) than for product or service innovations. Price-capping may also produce undesired incentives, such as to lower the quality of service provided although such side-effects may be controlled through side-agreements.

Some empirical studies have shown, at least in the short time, a positive influence of a switch to price-caps on the speed of infrastructure modernization (Spiller, Greenstein, & McMaster, 1994) whereas others come to the conclusion that there is no significant influence of the regulatory regime on the level and structure of infrastructure investment (Blank et.al., 1994). Some authors have also questioned, whether price-caps and other forms of incentive regulation provide insufficient incentives to engage in long-run investment projects, as infrastructure projects typically are. It is argued that, compared to rate-of-return regulation, price-caps increase the uncertainty as to the future return on investment and thus lead to a more cautious investment strategy (Gilbert & Newberry, 1994). Overall, the medium and long-run effects of different regulatory approaches need more careful modeling and empirical investigation.

Several countries with publicly owned telecommunications service providers have used an alternative approach by allowing the (monopoly) provider to earn significant profits with the obligation to reinvest into the information infrastructure. Equipment, controlware, and applications are frequently being developed jointly between the national service provider(s) and domestic and/or international industry. However, there is a great risk that such arrangements are abused by the different constituencies and interest groups in the process. The history of publicly owned telecommunications operators is full with examples of local politicians demanding investment in their district, suppliers strategically abusing a PTO for their purposes, and unions biasing decisions in their own interest. Nevertheless, properly executed, such models can have a booster effect on the domestic infrastructure.

In an environment of internationally mobile capital, such policies will all be evaluated the context of the enlarged set of investment options. For instance, policies to reduce the cost of capital for a service provider in order to stimulate infrastructure investment will have to compare favorably with investment opportunities in another region or abroad to be effective. Likewise, the imposition of an obligation to serve will be evaluated in a broader global context of investment opportunities. Thus, in a sense, national policy options become interdependent with policies adopted in other regions of countries. In such an environment, there is an increased likelihood that *unilateral* policies (such as tax incentives for infrastructure investment, subsidies, the establishment of a regulatory regime favorable to the service provider) will become less effective.

There is an inherent danger, that in the process of global competition for capital and technology, individual nations may try to provide rather favorable conditions for domestic and foreign investors to avoid the drainage of capital to other areas or to attract foreign capital. Many such favorable *bilateral* contracts between a carrier and a host government exist. This is especially virulent as more and more countries plan to privatize their national carriers and open their borders for foreign investment. Such international competition for investment funds may, at least temporarily, cause welfare losses. One way to overcome such "beggar my neighbor" policies could be to establish a *multilateral* international charter guiding investment flows in telecommunications as well as some minimal guidelines for the emerging regulatory regimes.

4.2 STRUCTURAL POLICIES FOR OPEN ECONOMIES

Structural policies affect the institutional and legal framework of the information infrastructure industries. They address such issues as the openness of the markets for customer premises equipment, services and facilities, ownership, as well as the particular regulatory framework that is established for the industry. As discussed, it is frequently difficult to determine the efficient level, structure, and quality of the information infrastructure via a policy-decision. However, this is a prerequisite to design efficient conduct-oriented policies. A solution could be the development of "meta-policies" by designing an institutional and legal framework for the evolution of the telecommunications infrastructure that allows experimentation with new technologies and applications while maintaining a desired level of ubiquitous service provision.

Such an essentially *evolutionary* approach has several advantages over discretionary policy approaches, although it may be implemented in conjunction with other more discretionary instruments. Most importantly, such approaches allow processes of social experimentation and learning. Measures in this second category include policies that affect the ownership regime of the industry (public, private, mixed, cooperative), conditions for market entry and exit, the institutional framework of the industry (for instance, the type and tasks of a regulatory agency, if any), or the processes of policy formation (for instance, through legislative processes, administrative action, or some other form of social consensus finding or corporatism, like in the German model of "social partnership or the South Korean approach to telecommunications research and development).

The opening of national boundaries for international capital flows affects the set of structural policies that can be adopted at the national level less than the set of conduct-oriented policies. Better use can be made of international alliances and other agreements to support infrastructure development. However, in an open economy the set of options is constrained by the fact that capital will only flow to locations with stable institutional frameworks and, in general, a pro-market orientation. This implies, for instance, that the ability for governments to plan the development of the national telecommunications infrastructure will tend to be reduced. Thus one can expect international pressure leading to a "convergence" of structural policies to a framework that is compatible with markets and competition.

Within these general constraints, a multitude of options for structural policies can be adopted that can contribute to a reduction of institutional failure in the provision of infrastructure services. However, not all economic governance mechanisms (markets, government, cooperative forms of infrastructure development) are equally suited for the various types of services that comprise the information infrastructure nor the types of infrastructure problems encountered.

Markets work best for private goods and, more general for excludable goods. However, in order for markets to work efficiently, several conditions must hold. First, no actor must possess detrimental market power. If markets are neither workable nor contestable, as is most likely the case in the network part of telecommunications, regulation may serve as a substitute for competitive forces. Second, the activity must not be afflicted with a high degree of externalities as may be the case for countries at an early stage of telecommunications network development. In this latter case, a proper pricing policy may cope with the problem. Third, planning processes in market environments are typically relatively short. If thus the deployment of an advanced telecommunications infrastructure requires long-term planning, markets may fail (intertemporal externalities). On the other hand, if technology changes rapidly, a short planning horizon may be beneficial. Fourth, markets are "indifferent" to the distribution of resources. If the achievement of universal service is high on the agenda of information infrastructure policy, this goal will have to be implemented with other means.

Government planning of the information infrastructure can be an appropriate means of achieving a fast and ubiquitous expansion of a modern telecommunications system and may or may not be combined with public ownership. If network facilities and services are both government owned and operated, some preconditions need to be met to increase the likelihood of efficient operations. These include a commercial orientation of the service provider, separate incorporation, and an arms length relation to other government functions. The government can also act as the coordinating agent but leave ownership and/or operation to the private sector, either through a concession or franchise model or via more indirect bidding and outsourcing models. In the latter cases, a proper regulatory framework is required. Government planning is frequently the only way to provide services that are non-excludable in character. It can also be a proper approach in situations with significant externalities.

Cooperatives or other forms of decentralized, self-managed models are probably best suited for situations in which the service provided has either strong club good characteristics (such as a broadband network) or has the character of a local common property resource (such as community access to information).

Under ideal conditions, there may be some degree of "institutional equivalence" (Bauer, 1995a) between different governance mechanisms and they may lead to similar results in terms of overall infrastructure performance. For instance, a government owned and operated system may lead to a similar overall performance as a privately owned and regulated system and either system may perform as well (or as poor) as a privately owned unregulated system. However, in general the overall governance systems differ in macro as well as micro-aspects, such as the ensuing geographic structure of infrastructure deployment, the degree of diversity of services offered, the availability of services to different classes of customers, and the prices charged. In general, a decentralized, market-oriented system will generate a more diverse, unequal information infrastructure than a more planned and publicly managed system.

In the light of such trade-offs it is important to design infrastructure policies that are customized to the needs of particular countries. Not all approaches are *feasible* under all circumstances. For instance, if the public sector is running chronic deficits, a policy that relies on public funds to support universal service goals will most likely be doomed to fail. Likewise, policies need to be feasible under the new constraints and opportunities created by the framework of open economies. Thus it is important to combine a package of structure and conduct-oriented policies that are both appropriate and feasible for the specific conditions of the country and the state of the telecommunications infrastructure.

4.3 IMPLEMENTING INFRASTRUCTURE POLICY IN OPEN ECONOMIES

In open economies, the set of feasible policies is not only shaped and constrained by national factors but also by factors in other countries and regions. Efficient national policies will have to take these new linkages into consideration and design approaches that are suitable to this new environment. However, within this framework there is a great range of policies that can be used to support national infrastructure development. What the "best" model for a country is depends to a certain degree on the status quo of infrastructure development and policies for nations with a good information infrastructure may not be suitable for nations with a poor telecommunications infrastructure.

For instance, market forces, while generating a more diverse information infrastructure, typically will fare much weaker in the provision of equitable and universal services. Countries in an early stage of the development of an information infrastructure will thus have to establish a set of explicit measures to generate and allocate funds to finance the expansion of service into high cost areas and to low income customers. At the same time, a clear vision as to what social goals should be pursued needs to be established and pursued in a fashion compatible with the overall structural approach to the telecommunications sector. If such an approach is not feasible, a more planned and integrated approach may be superior to a more market based policy.

New policies that rely on foreign capital to develop a national telecommunications infrastructure become available in an environment of an open international flow of capital into telecommunications investment. Several factors will determine the position of a country as a net exporter or receiver of foreign investment capital for telecommunications infrastructure projects. These include the expected growth rates of the segments of the telecommunications services industry in source and host countries, the stability and quality of the established legal and regulatory regime in source and host countries, and other economic factors such as the exchange rates between source and host country, or the repatriability of profits from host to home countries.

Given the spectrum of global investment opportunities (at least during the next several years), it seems likely that middle income countries in the faster growing regions of the developing world will be the prime recipients of foreign investment capital while the large telecommunications carriers in industrialized countries will be the main investors in these areas. Whether or not the richer countries will experience a net outflow of capital will depend on a number of further factors, for instance whether local telecommunications competition will be allowed, whether other than the traditional telephone companies will be allowed into the provision of telecommunications services, and so forth. While middle income countries in fast growing areas may take advantage of their attractive status as a host country, they may also lose some policy influence over their own national telecommunications service providers if these attempt to diversify internationally and do not have any obligations to invest their funds in national markets..

Part of this problem may be overcome by opening telecommunications markets for companies that do not pursue a global but only a local or national investment strategy and thus are not as susceptible to the rates of return on capital that can be achieved in other nations. Thus the logic of the evolution of global networks yet provides another rationale for the a liberalization of local telecommunications facilities markets for other than the incumbent providers, many of which seek international opportunities.

In an era of liberalized investment streams it is also important to pay careful attention to the general environment that is created for potential international investors. An opening of national borders or access to international funds alone may not be enough to attract foreign participation. In certain areas of telecommunications, especially in knowledge intensive market segments, foreign carriers may only become willing to transfer knowledge and expertise if they are allowed to directly invest in the host country. On the other hand, they may be rather reluctant to transfer knowledge and expertise in any other organizational form, say a joint venture, because they fear imitation and a future loss of market share. Likewise, the setting up of a regulatory framework will need significant expertise and training to signal professionalism and stability to the international investor community.

5. CONCLUSIONS

In this paper we analyzed the opportunities of national public policy institutions to pursue information infrastructure policies at the national level. We showed that the potential policy issues related to the development of an appropriate telecommunications infrastructure are complex and multi-facetted and demand differentiated approaches targeted to the specific efficiency, equity, or generic market failure problem. We further explored how these options are affected by the recent transition of the telecommunications sector from a by and large domestically organized industry to a sector in which major service providers select their investment projects on a global basis. In both areas of conduct-oriented and structure-oriented policies, the national choice sets are modified, expanded in some areas, such as the access to international capital, but constrained in others, for instance, by the fact that national investment opportunities are evaluated in the context of other international projects.

This situation may create the danger that individual nations in pursuit of their national policies adopt measures that lead to distortions in the international streams of capital, for instance, by granting highly favorable returns on the investment of international service providers. Other nations, on the other hand, that adopt too stringent controls on the profitability of foreign or domestic carriers, may face capital shortages and lose out to countries willing to provide more generous investment opportunities. Such distortions may only be a short time phenomenon if international organizations try to adopt measures that provide a more homogenized international environment for globally operating telecommunications service providers.

NOTES

(1) This paper is an abbreviated version of Bauer (1995b) where a more detailed discussion of all arguments can be found.

REFERENCES

Azoulay, Pierre (1995). "The GSM Standard: An Impetus for the Globalization of Mobile Communications?", Working Paper, Institute of Public Utilities, Michigan State University, East Lansing, USA.

Bauer, Johannes M. (1995a). "Alternatives to Private Ownership", in: Bella Mody, Johannes M. Bauer, & Joseph D. Straubhaar (eds.), *Telecommunications Politics. Ownership and Control of the Information Highway in Developing Countries*, Mahwah, NJ: Lawrence Erlbaum Associates.

Bauer, Johannes M. (1995b). "National Infrastructure Policies Under Conditions of International Capital Mobility." Working Paper, Institute of Public Utilities, Michigan State University, East Lansing, USA.

Bauer, Johannes M. (1995c). "The Anatomy and Reglatory Repercussions of Global Telecommunications Strategies", in: G. W. Brock (ed.), *Toward Competition in Telecommunications Policy. Proceedings of the 22th Telecommunications Policy Research Conference*, Mahwah, NJ: Lawrence Erlbaum Associates.

Bauer, Johannes M. (1994). "Globalization of Telecommunications Operators Under Conditions of Asymmetric National Regulation", in: G. Pogorel (ed.), *Global Telecommunications Strategies and Technological Changes*, Amsterdam: Elsevier Science.

Blank, Larry R., Witkind Davis, Vivian, & Reed, Catherine E. (1994). *Telecommunication Infrastructure In-*

vestments and State Regulatory Reform: A Preliminary Look at the Data. Columbus, Ohio: National Regulatory Research Institute.

Dixit, Avinash K., & Pindyck, Robert S. (1993). *Investment Under Uncertainty*. New Haven, CT: Princeton University Press.

Dunning, John H. (1981). *International Production and the Multinational Enterprise*. London.

Fuhr, John P., Jr. (1990). "The Subsidization of Rural Telephone Service in the U.S.", *Telecommunications Policy*, 14, pp. 183-188.

Gilbert, Richard J., & Newberry, David M. (1994). "The Dynamic Efficiency of Regulatory Institutions", *RAND Journal of Economics*, 25, Winter, pp. 534-554.

Graham, Stephen, & Marvin, Simon (1994). "Cherry Picking and Social Dumping: Utilities in the 1990s", *Utilities Policy*, 4(2), pp. 113-119.

Gramlich, Edward M. (1994). "Infrastructure Investment: A Review Essay", *Journal of Economic Literature*, XXXII, September, pp. 1176-1196.

Ruhle, Ernst-Olav (1995). "Foreign Direct Investment of Telecommunications Operators in Fixed Networks". Discussion Paper, Wissenschaftliches Institut für Kommunikationsdienste (WIK), no. 145, Bad Honnef, Germany.

Spiller, Pablo T., Greenstein, Shane, & McMaster, Susan (1994). Incentive Regulation and Infrastructure Deployment by the RBOCs. Working Paper, University of Illinois.

Trebing, Harry M. (1994). "Networks as Infratructure - The Reestablishment of Market Power", *Journal of Economic Issues*, 28, pp. 379-389.

Growth and Opportunity:
Telecommunications Services Markets in APEC Countries

John W. Houghton
Principal Economist
Bureau of Industry Economics
Canberra Australia
Ph +61 6 276 1858 - Fx +61 6 276 2367 - E-mail Jhoughton@dist.gov.au

ABSTRACT

This paper explores the nature and extent of telecommunication services markets in APEC economies. It begins with an analysis of some indicators of growth, and then examines telecommunication services market structures and conditions. While significant impediments to telecommunication services trade and investment remain, opportunities abound.

Introduction

This paper explores the nature and extent of telecommunication services markets in APEC economies. It begins with an analysis of some of the key indicators of extensive and intensive growth in APEC markets. The second section examines telecommunication services market structures and conditions including: the openness of services markets, the current state of international negotiations regarding trade in telecommunication services and the investment climate in APEC economies.

Growth indicators

There are a number of indicators of the development of telecommunication services markets. Indicators of network extension include growth in the number of fixed-network mainlines and cellular mobile subscribers. Forward estimates of these indicators through to the year 2000 show where most growth can be expected.

Fixed network mainlines

The US has the world's largest telecommunications network, with almost 157 million mainlines in 1994 (table 1). The Japanese network is the second largest with just under 60 million mainlines. China, Korea and Canada also have large markets. Mainlines in these economies in 1994 ranged from 27 million in China to just over 16 million in Canada. Australia, Taiwan and Mexico had between 8.5 and 9 million mainlines in 1994. Other APEC economies operate relatively small networks.

Over the decade 1984-94, APEC economies added almost 123 million mainlines to their telecommunications networks. Over 42 million of these were additions to the US network. China added 24.5 million mainlines over the decade, Japan 16 million, Korea 12 million, Mexico and Canada 5 million, Taiwan 4.6 million and Australia just under 3 million. Forecasts for mainlines to the year 2000 suggest a demand for an additional 130 million mainlines in China between 1994 and 2000. This puts demand in China well ahead of any of the other APEC economies. Forecasts suggest a demand from 33 million mainlines in the United States, 12.5 million in Korea and 11.3 million in Japan over the same period. All other APEC economies have a forecast demand of less than 10 million mainlines to 2000.

Clearly, in absolute terms, the larger national networks are experiencing the greatest growth. The

United States and Japan are expanding networks, and China's network is expanding at a rate that will see it eclipse Japan's within a few years and approach the size of the US network by the end of this century.

China (PRC), Thailand and Indonesia stand out as the economies experiencing the most rapid extensive network *growth rates* over the decade 1984-94. Growth in the number of mainlines in China exceeded 25 per cent (compound annual) over the decade. Thailand experienced a compound annual growth rate of mainlines of more than 18 per cent and Indonesia almost 17 per cent over the same period. Malaysia, Brunei, Chile and Korea form a second group, experiencing compound annual growth of mainlines of between 12 and 13 per cent. Growth has been slowest in New Zealand, followed closely by Japan and the United States. Growth was also relatively slow in Canada, Papua New Guinea and Australia. All grew at a rate below the rate of APEC total network extension, 5 per cent.

Looking forward to the year 2000, the high rates of extensive growth look likely to continue for China, Indonesia and Thailand. Estimates of mainlines in 2000 suggest a compound annual growth rate in excess of 18 per cent. Chile, Malaysia, Brunei and the Philippines are the other economies with forward growth estimates to the year 2000 over 10 per cent. New Zealand and Japan exhibit the least growth potential.

Cellular mobile

Cellular mobile telephony has taken off rapidly in developed and developing countries alike. In absolute terms, growth has been greatest in the United States, which added almost 19 million mobile subscribers between 1990 and 1994 (table 2). Japan added 3.5 million mobile subscribers over the same period. China, Canada and Australia were the only other APEC economies to add more than a million.

China, the Philippines, Chile and Mexico have experienced a compound annual growth rate in cellular mobile subscribers in excess of 100 per cent over the period 1990 to 1994. Japan, Singapore, the United States, Indonesia, New Zealand, Canada and Hong Kong have experienced compound annual growth below 50 per cent over that period.

Indicators of extensive and intensive development

Indicators of both extensive and intensive growth include forecast investment expenditure and projected carrier revenues. Infrastructure investment can be for both extension and upgrading, while carrier revenue increases can come from either extension or greater use of the existing network.

Again we find the larger networks forecast larger investment in absolute terms. China's forecast required investment expenditure 1995 to 2000 is $US194 billion, that for the United States is $US49 billon, Korea almost $US19 billion, Japan US$17 billion and Mexico US$12.6 billion (table 3). Of the other economies, only Indonesia, Taiwan, Thailand Malaysia and Canada forecast a required expenditure in excess of $US5 billion over the period.

The absolute level of investment in a country is, of course, relative to the size of the existing telecommunications network. Looking at investment requirements per existing mainline gives a better impression of the intensity of forecast investment relative to current position. Examining estimated investment requirements between 1995 and 2000 in US dollars per mainline we find that China stands out, having an estimated investment per mainline requirement in excess of $US7,000. Indonesia, Thailand and Chile form a second group, reporting an estimated investment requirement of in excess of $US2,000 per mainline. The only other economies reporting an estimated investment requirement over $US1,000 per mainline for the period are Malaysia, Brunei, Mexico, the Philippines and Korea.

Telecommunications carrier revenue

Revenue derived from telecommunication services is another indicator of both extensive and intensive growth. Zerby (1994) has estimated carrier revenue for a number of Asian countries to 2010, based on 1991 revenue and estimated growth in population and gross national product.

Among those economies for which data are available, China and Thailand exhibit the greatest estimated revenue growth over the 1990 to 2010 period, with compound annual growth in carrier revenue of the order of 17 per cent (table 4). Indonesia exhibits an estimated compound annual growth rate of almost 15

Table 1 Mainlines in APEC economies ('000), 1984-2000

	1984	*1994*	*2000*	*CAGR 1984-1994*	*CAGR 1994-2000*
Australia	5,851	8,850	11,044	4	4
Brunei Darussalam	19	62	138	12	14
Canada	11,827	16,756	20,090	4	3
Chile	481	1,545	3,817	12	16
China	2,774	27,230	156,859	26	34
Hongkong	1,664	3,149	4,527	7	6
Indonesia	536	2,521	7,666	17	20
Japan	43,959	59,870	71,205	3	3
Korea (Rep. of)	5,595	17,647	30,216	12	9
Malaysia	849	2,864	6,573	13	15
Mexico	3,504	8,493	16,924	9	12
New Zealand	1,260	1,658	1,955	3	3
Papua New Guinea	28	40	52	4	4
Philippines	505	1,110	2,158	8	12
Singapore	760	1,332	1,889	6	6
Taiwan, China	3,947	8,503	13,560	8	8
Thailand	519	2,752	7,528	18	18
United States	114,474	156,769	189,475	3	3
APEC Total	198,552	321,150	545,676	5	9
World Total (Estimated)	388,827	647,127	1,024,825	5	8
APEC per cent	51	50	53	-	-

Notes: Year 2000 estimates based on average growth rate in mainlines over the last 6 years.
Sources: ITU 1995a and 1995b.

Table 2 Cellular mobile subscribers in APEC economies, 1990-95

	1990	*1994*	*1995*	*CAGR 1990-94*
Australia	184,943	1,250,000	1,697,000	61
Brunei Darussalam	1,772	15,623	15,500	72
Canada	583,000	1,890,000	3,212,196	34
Chile	13,921	227,200	355,693	101
China	18,319	1,566,000	1,558,000	204
Hongkong	133,912	431,775	426,000	34
Indonesia	18,096	78,201	87,000	44
Japan	868,078	4,331,000	3,200,000	49
Korea (Rep. of)	80,000	960,258	850,000	86
Malaysia	86,620	571,720	550,000	60
Mexico	34,944	569,251	3,545,955	101
New Zealand	54,100	229,200	212,000	43
Papua New Guinea	0	0	0	-
Philippines	9,708	200,409	167,000	113
Singapore	51,000	235,630	232,000	47
Taiwan, China	83,482	584,326	590,000	63
Thailand	63,223	643,000	665,000	79
United States	5,283,055	24,134,420	23,213,718	46
APEC Total	7,568,173	37,918,013	-	50
World Total (Estimated)	11,166,800	54,783,800	-	49
APEC per cent	0.68	0.69	-	-

Sources: ITU 1995a and 1995b and *Asian Communications*, February 1995

Table 3 Telecom investment (US$ millions), 1990-2000

	1990	*1994*	*Investment req'd 1995-2000*
Australia	2,317	1,803	3,292
Brunei Darussalam	9	-	114
Canada	3,665	-	5,001
Chile	402	-	3,408
China	1,250	7,921	194,444
Hongkong	387	523	2,066
Indonesia	575	-	7,719
Japan	15,653	26,485	17,002
Korea (Rep. of)	2,968	3,634	18,854
Malaysia	296	1,219	5,564
Mexico	1,397	2,504	12,647
New Zealand	447	265	446
Papua New Guinea	25	-	17
Philippines	337	-	1,572
Singapore	251	342	836
Taiwan, China	1,534	1,791	7,585
Thailand	383	187	7,164
United States	20,600	-	49,059

Notes: 1990 investment data for Brunei is from 1991. 1995-2000 estimates are based on the average growth rate in mainlines over the last 6 years.

Sources: ITU 1995a and 1995b

Table 4 Annual carrier revenue (US$ millions), 1990-2010

	1990	*2000*	*2010*	*CAGR 1990-2010*
Australia	6,942	15,676	29,311	7
Brunei Darussalam	-	-	-	-
Canada	11,401	-	-	-
Chile	574	-	-	-
China	2,147	12,469	53,228	17
Hongkong	2,088	5,734	12,907	10
Indonesia	1,017	4,923	15,654	15
Japan	43,623	-	-	-
Korea (Rep. of)	5,074	18,149	52,706	12
Malaysia	952	3,319	9,706	12
Mexico	3,805	-	-	-
New Zealand	1,452	2,172	3,937	5
Papua New Guinea	110	146	301	5
Philippines	537	1,473	4,087	11
Singapore	1,159	3,892	10,067	11
Taiwan, China	3,253	11,335	27,258	11
Thailand	1,072	6,733	23,488	17
United States	130,700	-	-	-

Notes: Revenue projections in constant 1991 prices and US$ exchange rates.

Sources: ITU 1995a and 1995b and Zerby 1994 per cent, while Korea, Malaysia, Singapore, Taiwan and Philippines look set to experience compound annual growth rates of between 10 and 15 per cent. Hong Kong, Australia, Papua New Guinea and New Zealand exhibit estimated growth in carrier revenues of between 5 and 10 per cent.

Traffic

Intensive development involves making greater use of the existing network to deliver services. The main indicator of intensive growth is growth in traffic, measured as minutes of telephone traffic. Many countries have experienced rapid growth in long distance and international traffic due to income and price effects, technological change, deregulation and associated rate rebalancing, the internationalisation of commerce and the general 'shrinking' of the world. Among APEC economies there is an interesting mix of developed and developing economies exhibiting rapid growth in outgoing international traffic.

APEC economies generated 19 billion more minutes of outgoing international telephone traffic in 1994 than they had in 1984, at a compound annual growth rate of just over 22 per cent over the decade compared to a worldwide rate of 16 per cent (table 5). Interestingly, and reflecting the vigour of the Asia-Pacific region, APEC economies increased their share of worldwide outgoing traffic from 25 to 41 per cent.

In terms of absolute growth in outgoing international minutes over the decade the United States stands out, generating 11 billion more minutes in 1994. Hong Kong, Japan and China form a second group of economies, enjoying increases of between 1.1 and 1.5 billion MiTTs over the decade. Mexico and Canada are the only other economies to register increases of more than 500 million minutes.

China has experienced the most rapid increase in outgoing international telephone traffic, with a compound annual growth rate in MiTTs of more than 40 per cent between 1984 and 1994. Thailand, Malaysia, Hong Kong, Taiwan and Korea form a second group, having each experienced a compound annual growth rate in outgoing MiTTs of between 25 and 31 per cent over the same period. Only Papua New Guinea exhibits a growth rate below 10 per cent, while Brunei, Australia, Canada, the Philippines, Singapore, Chile and New Zealand exhibit growth rates between 10 and 20 per cent.

The rapid development of Malaysia and Thailand since the early 1980s is clearly reflected in these traffic figures. It is also noticeable that Hong Kong exhibits a high rate of growth relative to Singapore. This is likely due to its increasingly important role as a gateway to China. Among the more developed economies, growth in outgoing international traffic from Japan and the United States continues strongly.

Summary of market indicators

This analysis of indicators reveals that the developing economies exhibit greater growth potential than do the more developed. Nevertheless, the larger national networks offer some of the greatest growth potential in absolute terms. The markets of the United States and Japan are, and will remain major markets. China and Korea are large and rapidly growing markets. The potential opportunities in China are enormous. Economies like Korea, Thailand, Indonesia, Malaysia and the Philippines also exhibit excellent growth prospects.

Services market conditions

This section examines services market structures and conditions. It explores the openness of services markets, the current state of international negotiations regarding trade in telecommunication services and the investment climate in telecommunication services in APEC economies. One way to assess the openness to and potential for telecommunication services market development and trade is to examine some of the relevant indicators of growth and openness to trade and investment reported by the World Economic Forum (1993) and PECC (1995).

Among the economies for which data are available, Taiwan exhibits the fastest growth in services with an average annual rate of growth between 1980 and 1990 of 14 per cent (table 6). Korea, Thailand, Singapore and Indonesia exhibit growth rates of between 5 and 10 per cent, while only Mexico and

Table 5 International outgoing telephone traffic minutes (millions), 1984-94

	1984	*1994*	*CAGR 1984-94*
Australia	160	645	15
Brunei Darussalam	7	26	14
Canada	159	787	17
Chile	11	62	19
China	38	1,170	41
Hongkong	123	1,578	29
Indonesia	24	183	22
Japan	191	1,411	22
Korea (Rep. of)	36	363	26
Malaysia	13	186	31
Mexico	121	770	20
New Zealand	45	275	20
Papua New Guinea	8	21	10
Philippines	32	166	18
Singapore	85	451	18
Taiwan, China	46	502	27
Thailand	13	193	31
United States	1,883	13,121	21
APEC Total	2,995	21,909	22
World Total (Estimated)	12,104	53,551	16
APEC per cent	25	41	-

Notes: Some figures estimated as described in sources

Source: ITU 1995a and 1995b

Table 6 Services market indicators, APEC economies

	Annual average growth in services 1980-90 (%)	*Growth in value of service imports 1987-91 (CAGR)*	*Composite services trade indicator*	*Direct investment flows inward, 1987-91 average As per cent of GFCF*
Australia	3.7	13.6	5.8	9.7
Brunei Darussalam	-	-	-	-
Canada	3.5	12.3	5.3	4.1
Chile	2.9	7.0	3.3	22.6
China	-	-	-	-
Hongkong	-	31.2	-	-
Indonesia	6.7	9.8	5.5	2.4
Japan	3.8	24.7	9.5	0.2
Korea (Rep. of)	9.2	17.3	8.9	1.3
Malaysia	3.9	12.5	5.5	14.2
Mexico	1.1	9.8	3.6	5.4
New Zealand	1.6	1.8	1.2	5.1
Papua New Guinea	-	-	-	-
Philippines	-	-	-	-
Singapore	7.2	18.4	8.5	36.2
Taiwan, China	14.0	14.0	9.3	-
Thailand	7.8	27.3	11.7	6.6
United States	3.3	6.6	3.3	6.2

Source: World Economic Forum, 1993

New Zealand exhibit annual average growth rates below 2 per cent.

In terms of compound annual growth in the value of services imports 1987 to 1991 (based on US$ import values) Hong Kong and Thailand lead the field with CAGRs in excess of 25 per cent. Japan is the only other country for which data are available with a compound annual growth rate in the value of services imports in excess of 20 per cent. New Zealand, with a compound annual growth rate of 1.6 per cent, experienced the slowest growth in the value of services imports over the period.

A simple composite of growth in services and services imports suggests that, of those economies for which data are available, Thailand has the greatest growth. Japan, Taiwan, Korea and Singapore also show well on this composite indicator, suggesting that together these economies may represent the greatest potential for growth in services trade.

In terms of direct foreign investment flows inward as a percentage of gross fixed capital formation (1987 to 1991 average), Singapore is the clear leader among the economies for which data are available (table 6). Chile, Malaysia and Australia also experienced relatively high inward investment flows, while Indonesia, Korea and Japan experienced relatively low inward investment flows over the period. Clearly, services trade opportunities and direct investment opportunities exist in different measure in the various APEC economies, and different economies should, therefore, be the targets of specific trade and/or investment strategies.

Qualitative indicators of the openness of services markets are summarised in table 7. They include business opinion as to the ability of foreign investors to acquire control of a domestic company, the commonness of strategic alliances between domestic and foreign enterprises, whether government imposes restraints on the negotiation of cross border ventures and the availability of investment protection schemes for foreign partner countries.

In terms of a simple composite of these indicators Hong Kong, Singapore and Chile appear to be the more open to investment among those economies for which data are available. Korea, Thailand and Indonesia are perceived to be among the more restrictive in terms of inward foreign investment and participation. It should be noted, however, that data are not available for China. In its recent report on impediments to trade and investment in APEC, PECC (1995) rate China, Papua New Guinea, and Taiwan among the more restrictive economies in relation to FDI, with Thailand, Malaysia, Korea and Indonesia somewhat less so (PECC 1995, p102).

Trade in telecommunication services

Services trade accounted for between 15 and 20 per cent of all the trade of APEC economies in 1993 (PECC 1995, p65). Nevertheless, services trade faces many impediments. The recent PECC *Survey of Impediments to Trade and Investment in the APEC Region* (PECC 1995) suggests that 77.6 per cent of possible APEC services markets are impeded in some way (PECC 1995, p71). Telecommunications are among those services impeded.

Telecommunication services can be divided between basic carrier services (the operation of the public switched network) and value-added services (including such things as electronic mail, voice mail, electronic document interchange, online information and data processing services and code and protocol conversion). Most countries currently apply restrictions to the foreign operation and/or ownership of facilities-based carriers and basic services. Value-added services (VAS) markets are generally somewhat more open to participation and supply.

Basic telecommunication services remain on the GATS negotiating table. A negotiating group formed to pursue liberalisation of trade in basic telecommunication services is due to report by April 1996. However, most countries entered a list of value-added services on their GATS schedules, declaring them open to trade (DFAT 1994). Because negotiations are still going on these schedules represent a snapshot of 'intended' commitments as at 15 April 1994. Until the outcome of the current negotiations emerges they remain the best guide to telecommunication services market conditions (table 8).

Table 7 Investment perceptions, APEC economies

	A	B	C	D	Composite
Australia	6.3	6.5	7.6	4.7	6.3
Brunei Darussalam	-	-	-	-	-
Canada	7.1	6.6	7.9	6.2	7.0
Chile	8.4	6.8	8.1	7.0	7.6
China	-	-	-	-	-
Hongkong	9.7	8.7	9.7	5.5	8.4
Indonesia	5.1	7.0	5.8	6.5	6.1
Japan	6.1	7.4	8.0	7.1	7.2
Korea (Rep. of)	4.8	4.8	5.1	5.8	5.1
Malaysia	5.1	7.5	6.9	7.7	6.8
Mexico	7.3	7.6	7.7	5.7	7.1
New Zealand	8.2	6.6	8.7	4.7	7.1
Papua New Guinea	-	-	-	-	-
Philippines	-	-	-	-	-
Singapore	8.4	7.6	9.1	7.4	8.1
Taiwan, China	6.6	6.7	5.8	7.2	6.6
Thailand	4.4	6.3	6.8	6.6	6.0
United States	8.0	7.2	8.1	5.8	7.3

Notes: A - ability of foreign investors to acquire control of a domestic company
B - commonness of strategic alliances between domestic and foreign enterprises
C - whether government imposes restraints on the negotiation of cross border ventures
D - availability of investment protection schemes for foreign partner countries

Source: World Economic Forum, 1993

Table 8 Schedule of commitments - telecommunication services, 1994

	Basic	*VAS**	*Services*
Australia	Licensed	Open	- Answering services - E-mail / Voice mail - Online info & database retrieval - EDI - Value-added fax services - Code & protocol conversion
Brunei Darussalam	-	-	-
Canada	-	-	-
Chile	-	-	-
China	-	-	-
Hongkong	Closed	Open, but must form a company	- Code & protocol conversion
Indonesia	Closed	Open, limit of 5 companies	- E-mail / E-mail box / Voice mail - Time sharing - Videotex - File transfer - Home alarm services - Entertainment services - Management information svcs
Japan	Closed	Open for all Type II	- Type II services
Korea (Rep. of)	Closed	Open	- Online database & remote computing - some data transmission svcs
Malaysia	Closed	Open, must be a jv or acquisition of less than 30%	- Data transmission - Mobile data services - Telex and telegraph
Mexico	-	-	-
New Zealand	Licensed	Open	- E-mail - Voice mail - Online info & database retrieval - EDI - Value-added fax services - Code & protocol conversion
Papua New Guinea	-	-	-
Philippines	40% limit on foreign capital	License required	- Online info & database retrieval - EDI - Videotex
Singapore	Closed	License required	- E-mail / Voice mail - Online info & database retrieval - EDI - Online information & data processing
Taiwan, China	-	-	-
Thailand	Closed	License required Corporate entity and technology transfer requirements	- Online info & data processing - Online info & database retrieval - Videotex - Leased circuits - Teleconferencing
United States	-	Open	-

Sources: DFAT 1994

The most notable thing about these schedules is that they typically list no more than a subset of the major value-added services. Moreover, it is unclear how services not specifically listed in these schedules would be treated.

At their 1995 meeting in Seoul, the communications ministers of APEC economies agreed to make telecommunications and the information industry a model sector in achieving the free trade, investment and cooperation agenda laid out at the Bogor summit. This bodes well for the future development of telecommunications and information technology services trade, but the fruits of these efforts remain to be harvested. In the meantime significant impediments to trade and investment in telecommunication services, especially basic services, remain.

Investment strategies

Most APEC economies maintain restrictions on the level of private investment and/or the level of foreign direct investment in telecommunication services, especially facilities-based, basic services carriers. This places considerable restriction on the extent of opportunities in the telecommunication services markets. Nevertheless, there is an almost universal trend towards deregulation and the liberalisation of telecommunications around the world, and there are ever increasing opportunities for participation in those markets.

There are basically three methods of mobilising private capital for telecommunications development. They are: privatisation of the state-run operators, issuing operator licenses for the provision of public services and variants of the Build-Operate-Transfer (BOT) approach to project financing.

Privatisation has been favoured in Canada, Hong Kong, Japan, New Zealand and Singapore. No doubt there will be other privatisations and floats of corporatised, formerly state-owned telecommunications operators over the coming years. Issuing operator licenses has been a particularly popular way to introduce a fixed network competitor and cellular mobile and paging networks operators. Competitors have been licensed in Australia, Canada, Korea, Malaysia, New Zealand, Philippines and Taiwan. Mobile and paging operators have been licensed in almost all APEC economies except Brunei.

Variants of the Build-Operate-Transfer (BOT) approach are likely to become increasingly popular in countries in which the need for infrastructure development exceeds the supply of government finance. BOT strikes a balance between the mobilisation of private capital in network development and government ownership and control of the network. It can be an ideal solution. The end users get phones, the government retains ownership and control of the asset and private investors can participate in this fast growing services sector. However, BOT is not always appropriate. There has to be sufficient growth potential in the telecommunication services market for private investors to feel confident of a return, and financiers have to feel comfortable with the idea of the investor borrowing against a projected revenue stream rather than the project's fixed assets (Hayes 1995).

The very development success of some Asian countries is propelling them towards the BOT option. Faced with the possibility of their domestic economies overheating, tighter monetary policy settings restrict the flow and raise the price of (domestic) capital. This makes foreign backed BOT concessions all the more attractive as a source of investment capital.

Thailand has been a leader in using BOT schemes for telecommunications infrastructure development. In 1992 Thai Telephone and Telecommunication (TT&T) was awarded a 25 year concession to build and operate a 1 million line provincial network in Thailand, and TelecomAsia was awarded a concession to install a 2 million line network in Bangkok. These BOT schemes operate on an incremental basis, with TT&T and TelecomAsia gradually building up their respective networks, transferring ownership of exchange lines in batches to the government as they are installed, and then operating the facilities for an agreed concession period (Hayes 1995). This is effectively the BTO (Build-Transfer-Operate) variant.

Indonesia is also launching a series of BOT projects which aim to provide 2 million of the 5 million lines the government plans to install during the Repelita VI in various provincial areas (Hayes 1995). Similar BOT schemes are taking shape in India and Sri Lanka. Perhaps the greatest need for such an approach is in China, but to date BOT schemes have not been allowed under China's restrictions on the participation of private capital in the operation of the telecommunications network.

China's investment requirements are huge. As an indication, to raise China's teledensity to the level of Australia's (49.6), based on 1994 price and population levels and using the industry rule-of-thumb investment of US$1,500 per line, would require an investment of US$845 billion. A similar task exists on the Indian sub-continent.

Summary and conclusions

An analysis of indicators of growth reveals that the developing countries generally exhibit greater growth potential than do the more developed. Nevertheless, the larger national networks offer some of the greatest growth potential in absolute terms. The markets of the United States and Japan are, and are likely to remain major markets. China and Korea are large and rapidly growing markets in which new suppliers will be required to and can develop. The potential opportunities in China are enormous, but so are the difficulties of realising them. Economies like Korea, Thailand, Indonesia, Malaysia and the Philippines also have excellent growth prospects, and they have telecommunications regimes more conducive to trade and investment. Some of the larger and more developed networks, such as Canada and Australia also offer some good prospects.

Telecommunication services trade opportunities are greatest in countries with rapid growth and more open regimes. Of the economies for which data are available, China appears to be among the least open. Singapore, Hong Kong, the Philippines, Thailand and Korea have more open markets. And Hong Kong's role as the gateway to China looks likely to be a major one.

Foreign direct investment (FDI) opportunities in telecommunication services are greatest in economies experiencing and/or requiring rapid extensive development and opening to investment, including Indonesia, the Philippines and Thailand. The favoured modus operandi for investment are joint ventures, partnering and BOT, which clearly suggests that to succeed companies must work with local partners and not rely on direct sales.

Almost all countries, developing and developed alike, are embarking on considerable renewed investment in telecommunications infrastructure. A review of extensive and intensive growth potential tends to focus on the rapidly developing networks, but countries with more mature networks are also pushing forward with development and investment plans, often under the guise of developing a National Information Infrastructure.

Pressure for the reform of infrastructure services industries is coming from international negotiations opening up trade in services and from the need for capital to develop modern information infrastructures. With rapid development in the Asia-Pacific region and the opening of eastern Europe it is currently something of a capital sellers market. Only those countries that provide an attractive regulatory and operational environment, and those companies that understand capital markets, can access the appropriate institutions and have credibility are going to attract the necessary capital. There can be little doubt that this will increase pressure for the further deregulation of telecommunications and result in rapidly increasing market opportunities in the years to come.

References

AAP Asia Pulse (1995) *AAP Asia Pulse - Telecommunications* (Week 5)

APEC Telecommunications Working Group (1993) *The State of Telecommunications Infrastructure and Regulatory Environment of APEC Economies, Volume 1*, November 1993, APEC, Singapore.

—— (1994a) *The State of Telecommunications Infrastructure and Regulatory Environment of APEC Economies, Volume 2*, June 1994, APEC, Singapore.

522

—— (1994b) *Guide to the Investment Regimes of the APEC Member Economies*, APEC, Singapore.

APT (1994), *The APT Yearbook, 1994*, Asia-Pacific Telecommunity, Bangkok, Thailand.

*Asia*money (1994) 'Asian Telecommunications Guide' A*sia*money, October 1994.

BIE (1995a) *International Performance Indicators - Telecommunications 1995*, Bureau of Industry Economics, Research Report 65, AGPS, Canberra, Australia.

—— (1995b) *Potential gains to Australia from APEC, Open regionalism and the Bogor Declaration*, Bureau of Industry Economics, Occasional Paper 29, AGPS, Canberra, Australia.

Budde, P. (1995a) *Superhighways in Asia 1995/1996*, Paul Budde Communication, NSW, Australia.

—— (1995b) *Telecommunications Strategies 1995/96*, Paul Budde Communication, NSW, Australia.

DFAT (1994) *Uruguay Round Outcomes, Services*, Department of Foreign Affairs and Trade, Canberra, Australia.

Hayes, D. (1995) 'The BOT challenge' *Asian Communications*, March 1995, pp39-42.

ITU (1995a) *ITU World Telecommunications Indicators, 1994*, ITU, Geneva.

—— (1995b) *ITU World Development Report*, ITU, Geneva.

Millis, D. (1995) 'Developing by degrees' *Asian Communications*, March 1995, pp13-17.

OECD (1995) *Communications Outlook 1995*, DSTI/ICCP/TISP, OECD, Paris.

PECC (Pacific Economic Cooperation Council) (1995) *Survey of Impediments to Trade and Investment in the APEC Region*, APEC, Singapore.

Pickles, M. (1995) 'Cellular Supplement' *Asian Communications 9(2)*, February 1995, pp19-30.

Telecom Asia (1993) 'Directory of public network operators' *Telecom Asia*, December 1993, pp9-33.

—— (1994) 'The state of the art' *Telecom Asia*, April 1994, pp38-44.

World Economic Forum (1993) *The World Competitiveness Report*, World Economic Forum, Switzerland.

Zerby, J. (1994) *Demand Projections for Telecommunications services and equipment to Asia by 2010: an update*, Bureau of Transport and Communications Economics Occasional Paper 109, BTCE, Canberra, Australia.

HONG KONG AFTER 1997

The Effect on Telecommunications Services

Alan B. Kamman
Vice President: Asia/Pacific
Cambridge Strategic Management Group
Cambridge, MA USA

1. ABSTRACT

On June 30, 1997, the Government of the United Kingdom of Great Britain and Northern Ireland turns over contol of Hong Kong to the Government of the People's Republic of China. This paper discusses the possible effect the changeover will have on the Companies now supplying fixed telecommunications services to the colony.

2.0 BACKGROUND

2.1 GENERAL DESCRIPTION

Over the past two decades, Hong Kong has emerged as a major economic powerhouse, earning a well-deserved position as one of the four "tigers" of Asia. A tiny speck of territory ranking 89th in terms of population, Hong Kong is today the world's eighth largest trading economy. Hong Kong operates the world's largest container port, and second busiest airport in terms of cargo. Per capita income of over US$21,000 on a purchasing parity basis exceeds that of countries such as Britain, France, Canada and Australia. Gross Domestic Product grew by 5.5% in 1994, following increases of 5.8% in 1993, and 6.2% in 1992. The GDP forecast for 1995 is about 5%. Its telecommunications system is ranked as one of the best in Asia.

The territory is the preferred base for regional business. Over 700 international institutions maintain regional headquarters in Hong Kong. A major attraction is the fact that Hong Kong is at the heart of the Asian economic miracle, the gateway to China, equidistant from North and South Asia, and has the highest quality of data, voice, wireless and video facilities.

2.2 CURRENT ENVIRONMENT

The current environment in Hong Kong can be characterized as an atmosphere of both optimism and anxiety. Optimists, including many local and international business groups, confidently expect Hong Kong to continue as an economic dynamo; a major regional center for business and finance, and entrepot for China. Other individuals and political groups fear contamination by a repressive system that will be intolerant of dissent and any form of democratic representation. They mistrust the intentions and sincerity of the Chinese leadership. Moderates take the middle road and anticipate the establishment of a stable yet cautious relationship between the Hong Kong Special Administrative Region (HKSAR), as it will be designated on July 1, 1997, and China.

2.3 THE EFFECT ON HONG KONG'S TELECOMMUNICATIONS SERVICES SECTOR

In the midst of this uncertainty, every sector questions the effect on their own collection of companies and industries. The purpose of this paper is to examine the consequences to the Telecommunications Services Sector caused by the change of Government on July 1, 1997, and thereafter. To keep the scope manageable, the paper uses the fixed-network as its model. Obviously, the wireless field will be affected in similar ways.

3.0 TELECOMMUNICATIONS SERVICES

3.1 OFFICE OF THE TELECOMMUNICATIONS AUTHORITY (OFTA)

As is now well known, OFTA was established to control competition in Hong Kong. It allocates telephone numbers, oversees interconnection arrangements, awards licenses, and otherwise keeps a supervisory eye on the telecommunications services industry. However, in connection with issues which span the change of Government date, it does not act independently.

For example, since the recently awarded fixed-network licenses will be effective on a permanent basis, the Sino British Joint Liaison Group (JLG) had to approve the concept and license awards. Even though the British Government is in total charge until midnight on June 30, 1997, it has agreed to discuss all issues which will affect the Chinese rule. While OFTA could act unilaterally, probably the Chinese would cancel all agreements after July 1, 1997. Considering the investment the new telecommunications competitors will make, they want assurances of being able to continue after the changeover. Hence the need for JLG approval in advance. Here is the first instance of where the impending Chinese rule is being felt.

3.2 HONGKONG TELECOM

3.2.1 OVERVIEW

Hongkong Telecom (HKT), with 57% ownership by Cable and Wireless, is the prime provider of domestic and overseas services. Despite the introduction of competition on June 30, 1995, it continues to grow. Over the years, a monopoly on domestic and international calls has allowed Hongkong Telecom to build perhaps the most advanced network in Asia, and to reap enormous profits. HKT contributed 73% of C&W's operating profit in 1994.

Summed up, financial highlights of 1995 (March 31st fiscal year) compared with 1994, indicated an 11% growth in Turnover, a 13% growth in Operating Profit, a 15% Profit Attributable to Shareholders, a 15% growth in Earnings per Share, and a 16% growth in Dividend per Share. Operating profit by type of service shows that 93.5% came from telecommunications services, 4.1% came from equipment sales and rentals, while 2.4% came from computer, engineering and other services.

3.2.2 HKT'S INTERNATIONAL NETWORKS

HKT has the most extensive international network in Asia, with the possible exception of Japan; more fiber, more cables, etc. China is HKT's largest destination, just as Hong Kong is China's largest destination. HKT's networks interconnect both to the C&W global network, and to WorldSource (AT&T/Singapore Telecom/KDD ownership). Hence they are in an excellent position to serve multi-national customers.

3.2.3 OTHER SERVICES

In addition, HKT carries out business development roles in the telecom field. This includes investments in China, and shared ownership of the second GSM network in Singapore.

HKT is a leading player on the wireless side. HKT is proud of its GSM network, which now permits MTR (Subway) riders to use their wireless phones. HKT is bidding for a PCS license (there are 14 bidders for up to 6 licenses), and also a cordless access service license. Awards are expected to be announced at the end of 1995, or early in 1996. It has major plans to combine service with fixed and cellular offerings.

3.3 THE COMPETITORS: BRIEF OVERVIEW

3.3.1 GENERAL

There are now three competitors chosen to compete with HKT in the provision of fixed-network service. In the near future, none will offer the communications and relationships with the Chinese mainland telecommunications authority that HKT has at this time. However, with New World's extensive construction/real estate activities in China, New T&T's ability to use the Wharf-owned cable TV operation, and with Hutchison's ability to leap-frog upon majority owner Li Ka-Shing's superb China contacts, eventually the playing field may level.

3.3.2 NEW T&T

Hong Kong conglomerate Wharf Holdings plans to spend HK$6 billion (US$770 million) to support their embryo fixed line telecommunications service, named New T&T. They state they will do all financing internally. Their goal; within ten years, to serve 15% of the residential telephone market, and 20-25% of the business market. (They expect to be covering 90% of Hong Kong by that time). Break-even is expected within 5 years.

Wharf Holdings is in the cable TV business, and has a fiber network in place. Basically, it uses the Mass Transit Railway (subway) tunnels to run its cable, and each station either has or will eventually have access points. Currently 6000 kilometers of fiber are in place. The architecture is Sonet ring-on-ring. It uses a DMS-100 switch, and a Newbridge Network. It is fully managed and fully monitored. It offers Centrex service, and will have a Centrex ACD by December, 1995. Their investment so far: US$ One billion!

Wharf has another advantage besides its in-place network; it owns some of the best real estate in Hong Kong. It also has Wheelock Buildings, and this represents 12% of Wharf's market. It can offer its tenants, which includes much of the financial services industry, excellent data and wideband service over the fiber network.

Because of their cable TV liaison, New T&T is up and running. Using the fiber optic network strung through the Mass Transit Railway system, they began connecting customers in the Tsim Sha Tsui, Central and Causeway Bay Districts less than three months after receiving their license. New T&T is expecting to compete in high-speed data transmission services and enhanced messaging, as well as conventional telephony, using its newly installed Northern Telecom DMS 100 switching system.

3.3.3 HUTCHISON COMMUNICATIONS

Hutchison Whampoa plans to invest HK$ 3.5 billion (US$ 450 million) in its subsidiary, Hutchison Communications. More circumspect in announcing goals and objectives, the Company states that they will start by targeting Hong Kong's key business districts, and expand to other business and residential areas. Target date to begin is the 4th quarter of 1995.

They state that personalized phone numbers and value-added services on an Intelligent Network Service (INS) will be the basis of their strategy. At this writing, Hutchison is testing an Intelligent Network Switch from Siemens AG, and they will develop a companion optical fiber digital transmission network.

3.3.4 NEW WORLD TELEPHONE

New World Group, owners of extensive hotel properties in Hong Kong and China, has teamed with INFA Telecom to enter HK's domestic market. They will provide fixed network, paging and mobile services. Their initial investment is HK$2 billion (US$250 million). Their first switching center is installed in the New World Centre, and provides lines to Tsim Sha Tsui, Central and Wanchai. The goal is to provide coverage of 80% of Hong Kong within 18 months (counting from June 1, 1995).

They offer international service (through the HKT gateway), their own global credit card (GO card), and call-back service with lower rates. The calling card is a "smart card," offering abbreviated private call list features, from wherever it is used.

New World owns five hotels in Hong Kong, including the New World Harbour View, and the Grand Hyatt. These will be, of course, "captive bases" once plant is in place.

New World Telephone does not plan to concentrate on the China market until after 1997, and all uncertainty is gone. Prior to that, they will work to accomplish their goals within Hong Kong. However, once entering China, New World has at least one hotel in every major city; a major "captive base."

3.4 THE BATTLE FOR INTERNATIONAL REVENUES

HKT's biggest concern at present is loss of international revenues. To stay competitive, they announced (July 21, 1995) a slashing of up to 21% off calls to North America (21% to the U.S. and 15% to Canada.) The cuts are on routes where the company is facing the stiffest competition from new competitors. It offers no reductions on calls to China at this time. China is the destination of more than half of the territory's international calls, and on which it currently faces no competition. Calls to Taiwan, the third most popular destination for Hong Kong callers are also unchanged. (According to HKT, their cross-agreement with Taiwan precludes any cuts.)

Of course this started a cascade. New World Telephone announced they would cut calls to the U.S. and Canada on August 1, by an unspecified amount. New World claims that their tariffs were 33% less than HKT's before the HKT cut.

HKT's main competition on North American routes remains the "Callback" Companies. Not only is there competition by the "fly-by-night's," but New World Telephone, Hutchison Communications, and New T&T all offer callback services. One callback company, CTI, claims it is carrying 15% of calls to North America. If accurate, it means they have a HK$1.5 billion business. Callback companies are not illegal in Hong Kong. As a matter of fact, The *South China Morning Post* quoted Office of Telecommunications Authority, Director-General Alex Arena, as saying, "Any reductions are good news for customers. Consumers are now looking at a range of different offers - it's up to them to choose the best deal." He ruled call-back legal in March, 1995.

3.5 VIEWS OF THE TELECOMMUNICATIONS AUTHORITY

The Telecommunications Authority in Hong Kong is bullish on the new independents. At the same time, it sees growth so strong that it believes there will be no major adverse effect on HKT, although it realizes that HKT will lose some business. It still believes that, overall, HKT's income will rise. The Authority envisions the Hong Kong market increasing by a multiple of 4-to-5 times (doubling in terms of real dollars) within the next decade.

The Telecommunications Authority sites Wharf's objective of bringing optical fiber to within approximately 10 meters of one quarter of homes/offices. Wharf claims that within three years they will be able to cover 90% of Hong Kong's population.. The Authority points out that within HK, there are 70,000 cable-kilometers of fiber; most reaching either to the cross-connect boxes close to customers' premises, and, in the case of new buildings, directly into those buildings. Furthermore, the tandem trunks connecting Hong Kong's 140+ Central Offices are 100% fiber. The C.O.'s themselves are all digital.

At this time, a significant amount of fiber is tied into intelligent buildings. The Authority has encouraged builders to pull fiber directly into all their ducts during construction. This will enable multiple access to every competitor. Intelligent buildings are definitely an attraction of the present, not the future, in Hong Kong.

4.0 THE EFFECT OF THE 1997 CHANGEOVER

4.1 GENERAL

The year 1997 is likely to be the Year of Pageantry; basically a non-event year. The flags will change; the bands will play, the Governor will step down, a highly respected Chief Executive will take over, and the composition of the current Hong Kong Legislature as of June 30th might be different on July 1st. However, initially there will be no major policy changes. There is a high degree of probability they will come later.

4.2 THREE SCENARIOS

Certainly, there is no way of predicting exactly what will happen after changeover which will occur approximately 500 days after this paper is being presented. Therefore, three scenarios are postulated:

Status Quo
Militancy
Gradual Change

4.2.1 THE STATUS QUO

The Sino-British Joint Declaration states that the policies set out in the Joint Declaration will be stipulated in a Basic Law to be enacted by the National People's Congress of the People's Republic of China, and will remain unchanged for 50 years after 1997. Specifically, Socialist policies applied in the mainland will not be applied to the Hong Kong Special Administrative Region (HKSAR), which will maintain its previous capitalist system and life style for 50 years after 1997.

If this scenario prevails, there will be, of course, no effect on the telecommunications community, except for changing supply and demand conditions in the marketplace, and tecnological advances.

This scenario will probably not prevail in its entirety.The Chinese believe that Hong Kong has already violated the Basic Law through insistence on 100% direct elections, which just took place. The Chinese solution to the problem will be to substitute a new Legislature for the present Legislature on July 1, 1997. (Originally there had been an informal agreement for a "Through Train," i.e. the Legislature elected in 1995 would serve its full term until 1999. This, according to both parties, would ensure a smooth transition.)

4.2.2 MILITANCY

During the period of unrest caused by the Tiananmen Square situation, an estimated 500,000 Hong Kong citizens gathered in Chater Park to protest China's violence toward the students. Later, a group of Hong Kong citizens helped dissidents sought by Chinese officials to escape through Hong Kong to Europe and the United States.

The Chinese immediately put Hong Kong on their "Suspect List," and accused it of fostering political unrest, and supporting groups whose objectives are to overthrow the Chinese Government. As a matter of fact, during the drafting of the Basic Law two years later, this festered in their minds, and affected the wording in several sections.

When the Chinese are in control after 1997, there is little doubt that they will prohibit such demonstrations. If, for example, China made some hostile moves toward Taiwan, and the Hong Kong people demonstrated in force, it is probable that troops both within Hong Kong and those situated across the border in Guangdong Province would move in immediately to stop demonstrations.

That would lead to heavy control over the HKSAR, starting immediately. "Heavy Control" in a militant situation means control of all communications facilities; broadcast, video and telecommunications. Troop occupation of telecommunications centers might occur until the in-place top officials could be replaced by others deemed totally loyal to the mainland.

Those residents with valid passports for another country would leave Hong Kong,as might major institutions. The result would be strong economic hardship on the telecommunications providers.

Fortunately, the chances of the Militant Scenario are small also. However, it must be considered. Almost all global companies with regional headquarters in Hong Kong have top secret contingency plans for removing personnel and money if any such disasters occur. It is important to note that the plans were not placed into effect because of the Chinese takeover; most have been in effect since the mid-60's "Cultural Revolution" riots in Hong Kong, which were attributed to elements in favor of Mao Zedung.

4.2.3 GRADUAL CHANGE

This is the most probable scenario. The reason is that through 4000 years of Chinese history, bureaucracy has prevailed. There is nothing in their past that can prepare the Chinese to understand the importance of creativity and non-interference to promote entrepreneurship. Therefore, it is probable that the Chinese will increase bureaucratic oversight.

The Chinese Government wants Hong Kong to succeed and prosper. More than 60% of the funds flowing into Hong Kong come from Mainland China. Hong Kong is China's second largest trading partner after Japan. Many Chinese mainland officials have their sons and daughters well placed high up the corporate ladder in Hong Kong companies. The concern is that the Chinese will not know how to keep a "hands off" policy.

Under this Scenario,the telecommunications companies will continue to be very profitable, and the Chinese will want to participate in that success.

Currently, HKT has 12.5% of its stock owned by China's CITIC. (Cable & Wireless now owns 57.5%. The rest is in the hands of funds and private investors.) Some highly placed telecommunications executives in Hong Kong postulated that after 1997, China will probably demand a bigger share - perhaps 51% or more. They will want control.However, evidence doesn't necessarily support this theory. For example, over the years CITIC has reduced its ownership from 18% to 12%.Furthermore, Hongkong Telecom executives mentioned that discussions of increased ownership have never arisen in their many meetings with Chinese officials. They believe that China is comfortable with the present ownership structure.

Another theory advanced is that the Chinese Government will set up competing fixed-line services. The Chinese could easily arrange call-back services to take the international business away from HKT. They could set up clusters of switches, put companies into Hong Kong, funnel traffic into

Southern Province cities like Zhuhai and trunk it back to Beijing. They have the capacity to do that now. (Currently, Call-back within the mainland is prohibited by Law, but this could change.)

Asia Pacific Satellite Company (APSTAR) is owned by the Ministries of PTT, Defense and Electronics. In addition, there is ownership by the Great Wall Industries, which own the Longmarch space vehicles. In addition, the competitive (to the MPT) telephone company, Unicom, is owned by the Ministries of Railway, Power, and Electronics, plus an additional 15 smaller industries. Even the People's Liberation Army has a small position in the ownership. There is little doubt that they can do what they want after 1997, and especially after 2006.

Hong Kong is "the cream" in the minds of the Chinese, and their philosophy is that all relevant Ministries should share in its success. Telecommunications is a prime field for this sharing.

4.3 GUANXI

4.3.1 DEFINITION AND EXAMPLES

Relationships ("Guanxi") will play a major role after the transition. Guanxi is centuries old in the oriental tradition, but it assumes more importance to Hong Kong businesses as 1997 approaches. Many companies already have taken steps to assure that they will be looked upon favorably during future contract awards.

For example, Hongkong Telecom, initially under the strong leadership of Cable & Wireless, paid little attention to what is now called, "localization," i.e. the placing of ethnic Chinese in positions of high authority. It was the British Empire which supplied expatriates who rose through the ranks to the top.

Now, "localization" will change things. For example, when HKT Chief Executive Mike Gale died, Linus Cheung took his place. Mr. Cheung is well-respected among both the Chinese and expatriate community in Hong Kong, and has excellent connections within China.

4.3.2 THE "PRINCELINGS"

Furthermore, Mr. Ken Lu was appointed China Director, within HKT. Mr. Lu is the son of Mr. Lu Ping, Director of the Office for Hong Kong and Macao Affairs. This office, located in Beijing, controls the transition of both territories, administering the orders of China's National People's Congress, the State Council and the Country's leaders. Obviously, the connections of Ken Lu's father are superb.

It is no disparagement to Mr. Lu's abilities and his direction of the group of managers within HKT who deal extensively, effectively and profitably with China, to point out that he falls under a category of leaders in Hong Kong referred to as "Princelings," or "Princes." These are sons (and in a few cases, daughters) of highly placed mainland Chinese officials who are employed by mega-companies primarily to assist in winning contracts.

Mr. Lu was educated in China and the U.S., and has worked for private sector companies before he joined HKT last year.However, contacts, friendship and trust were well established between HKT and the MPT long before Mr. Lu joined the firm.

Furthermore, HKT and C&W had started to invest time and resources in China long before foreign multinationals became serious about investing in China. C&W Chairman Lord Young has established good personal relationships with the Chinese leadership throughout the years, which started many years ago when he served in the Cabinet. At the working level, there have been a number of ongoing projects throughout the years between HKT and the MPT. MPT has sent senior engineers for training at HKT's facilities in Hong Kong, as well as at C&W's facilities in England. HKT donated analog equipment to China when HKT moved toward digitalization. HKT's current Chief Executive, Linus Cheung also established strong working relationships with senior Chinese officials during his post assignment at Cathay Pacific.

All the HKT fixed-network competitors are well positioned; perhaps none better than Hutchison Communications, since the leader of the Mother Company, Hutchison Whampoa, Li Ka-shing, is presently extremely well-regarded by the mainland government. Hutchison is so sensitive to this, that the leaders of Hutchison Communications, the subsidiary, refused to permit the author to interview them, for fear of something being placed in print which would embarrass the Chairman.

New World Telephone, through the New World Holdings, can also call on key mainland leaders for help. With hotel property in almost every city of importance in China, it is obvious that their contacts over the years have been superb.

The downside, of course, is that relationships could change within the Mainland. To quote a corporation Chairman, "Today's peacock is tomorrow's feather duster." A Princeling who has only guanxi to offer, can become ineffective overnight. More important, if his relative or high mainland contact is declared totally out of favor with the National People's Congress, the Communist Party or State Council, he can become a liability.

4.4 CONTRACTS

Some worry has arisen concerning the awarding of contracts after the Chinese take over in 1997. The worry is that only companies in favor with China will gain awards. More important, companies out of favor may lose what they have already won. However, the negativists fail to point out that a high level of "selection" was exercised by the British over the decades. Looking ahead, it may be far easier for non-Chinese companies (with good guanxi) to gain awards, than when the British were in control. Certainly the Americans are counting on this.

With Hongkong Telecom becoming less British and more Chinese, and its three competitors being predominately Asian, the Americans and others hope for a more level playing field in bidding and winning. "Localization" will benefit the new Hong Kong Special Administrative Region

4.5 THE ELECTIONS OF SEPTEMBER, 1995

As far as influence is concerned, the pro-democracy forces won 28 of the seats in the Legislature; two seats short of majority. The biggest winner within this group was the Democratic Party, which had 16 of its members elected.

That notwithstanding, the pro-Beijing electors represent a strong balance within the Legislature. At best estimate, they can summon up 26 votes when necessary to act as a bloc. The bloc includes a number of extremely influential Legislators, many of whom ran unopposed, who serve on powerful Chinese committees such as the Preliminary Working Committee.

The effect will be to change the pro-business Legislature elected in 1991 into a more grass-roots oriented body. This will affect their opinions concerning social and economic issues. The shift could spill over to business, causing increased expenses for additional benefits and possible restriction on labor importation. No strong effect should be felt by the Telecommunications Service Providers.

In closing, it is important to note that at this writing, the Chinese are adamant about dissolving this elected Legislature after July 1, 1997, and creating a new Legislature. Hence, the 1995 Legislature may be inoperative within 18 months.

5.0 SUMMARY AND FINAL REMARKS

5.1 SUMMARY

On balance, the Telecommunications Service Industry should survive the changeover on July 1, 1997, with some changes. Paramount among these may be the entrance of mainland-based telecommunications entities which will compete with the incumbents. An area of major competition could be the Chinese establishment of call-back services to permit lower-rate calling from Hong Kong into Guangdong Province, Shanghai and Beijing, assuming China legalizes call-backs. This has been postulated, although at this writing, call-backs are still illegal in China.

All carriers, new as well as the long-established, should continue to grow and be profitable, according to the predictions of Hong Kong's Telecommunications Authority. They will benefit from the desperate need for expansion within the mainland and their unique geographical and ethnic position.

All the carriers have participated in localization. All, in some manner or other, are well connected in Beijing. Most particularly, Hong Kong business tycoon Li Ka-shing's ownership of Hutchison should prove of value, as should Ken Lu's position within Hongkong Telecom. New World has extensive properties in China, with attendant excellent relations, as is true of Wharf Holdings' New T.& T. The potential new competitors from the mainland will have a great deal of "home" power.

The bottom line: Hong Kong will remain an international financial center, with more than 80% of its businesses service-based, and will continue to provide opportunities for profit. The base upon which this success rests, without exception, is Hong Kong's global telecommunications connectivity.

RECENT DEVELOPMENTS RELATED TO NEW TELECOM SERVICES, PRIVATE SECTOR PARTICIPATION & REGULATORY POLICIES IN SRI LANKA.

A D V N Kularatna
Principal Research Engineer
Arthur C Clarke Centre
Moratuwa, Sri Lanka

Gamini Gunawardana
Executive Director
CeyCom Global Communications Ltd
Ceylinco House, Colombo 1
Sri Lanka

P M Wickremasinghe
Project Manager
CeyCom Global Communications Ltd
Ceylinco House, Colombo 1
Sri Lanka

Lakmini Wijesundera
Project Co-ordinator
CeyCom Global Communications Ltd
Ceylinco House, Colombo 1
Sri Lanka

1. ABSTRACT

Sri Lanka, with its long history related to telecom services, has not yet reached the world averages related to telecom penetration. However, within the last 8 years, many private operators have entered the telecom arena and provided many special services other than land line services. The most recent development was that the Director General of Telecommunications announcing the deregulation of voice services via Wireless Local Loop (WLL) systems. The article attempts analyzing the current scenario.

2. INTRODUCTION

Sri Lanka is an island nation with a population of almost 18 million concentrated into 65,607 sq.km. It is relatively poor, with a per capita GNP of US$ 580. A former British colony, Sri Lanka has been independent since 1948. Its economic policies may be periodised as traditional plantation based policies'(1948 - 1956), import substitution industrialization policies (1956 - 1977) and export oriented open economy policies (1977 to the present). Sri Lanka generally scores high on physical quality of life (PQLI) type indexes because of relatively well developed educational and health systems. Literacy levels are high for a third world country and population growth rates are low (1.3% in 1989). Sri Lanka has a tradition of civilian led, democratic governance, with multiple political parties and more or less regular elections. Within the last decade, due to terrorist activities in the northern part of the island the government was forced to spend heavy expenditure on military.

3. DEVELOPMENT OF TELECOM INFRASTRUCTURE PRIOR TO 1990

Sri Lanka has a recorded telecommunications history from the year 1858. At the early stages of development towards 1966, 23 Strowger exchanges were installed in metropolitan Colombo areas for introduction of subscriber trunk dialling. The Outer Colombo Area Development Project 1 (OCADS 1) was completed in 1973, equipping major cities outside the capital area with cross bar switches and establishing microwave and cable inter exchange links. In 1976 Sri Lanka was linked to foreign countries via INTELSAT and the first international gateway was commissioned providing a limited capability for international direct dialling. In 1980, little over 60,000 direct exchange lines were in operation with total number of telephone lines over 80,000. Exchange capacity at this time was approximately 93,000 lines and there were no digital exchanges.

After 1977 normal growth of demand had

been accelerated by the open economic policies of the government and high usage of available telephone lines contributed to difficulties in completing calls. Towards early '80s digital exchanges of the types E10 (CIT Alcatel) and NEAX (Japanese) were introduced to the telecom infrastructure and the Colombo metropolitan areas were getting updated with these new exchanges.

4. REFORM PROCESS IN THE '90S

Following some restructuring process in the telecom sector many important reforms were happening during the last 5 years [Ref 1]. Three important elements in the process were:
(a) Establishment of regulation
(b) Corporatization
(c) Introduction of competition

Sri Lanka telecommunications Act No. 25 of 1991 enacted in July 1991 is of central importance to all three processes. Parts I and II of this legislation creates a regulatory authority, the office of the Director General of Telecommunications, and specifies the powers of authority. Part III transfers all assets and liabilities of the Department of Telecommunications (SLTD) to the newly created fully government owned statutory corporation known as Sri Lanka Telecom (SLT), unless specifically excluded by the agreement between Minister and Corporation. Part IV provides for transfer of employees from the Department to SLT. Provisions defining rights of eminent domain for telecommunication operators are set out in Part V of the act and various offenses pertaining to telecommunication operators are described in Part VI.

Prior to 1991 there was no telecommunication regulation. The regulatory authority created by the Act consists of one person, and not multiple commissioners as in the case in most jurisdictions. Minister of Telecommunication was given broad powers and can over-rule the director General. Sri Lankan telecom regulatory hence created is quite different from the conventional US regulatory agency which is given a degree of independence from the executive and legislative branches. The fairness of Sri Lankan authority's decisions appears to be safeguarded only by the conventional Westminster principle of ministerial accountability to parliament.

In February 1990, Sri Lanka Telecom the successor to the Department of Telecommunications was established by an incorporation order under the provisions of the State Industrial Corporations Act (No. 49 of 1957) and what the Telecommunication Act did was to fill this empty shell with the assets, liabilities and the employees of the Department of Telecommunications. One month after the act came into effect the Minister, on recommendation of the Telecom Authority engendered by the Act issued a 20 year license to SLT completing the process of corporatization of the Government Department.

With the formation of the SLT, license issued to SLT specified the ranges of authorized services namely telephone services, public telegraph service, telex service, data transmission, maritime mobile service, facsimile service, international television transmission, international photo telegram service, voice cast transmission, IDS (SATNET) service and INMARSAT service. However services such as pay phone services, cellular services and paging service have been left out of the license.

5. CURRENT TRENDS IN THE ECONOMY

Sri Lanka possesses many of the hallmarks of a low income country - e.g. urbanization of just 22% and a per capita income of around $580 which places it at the top end of the World Bank's low income category. Sri Lanka's

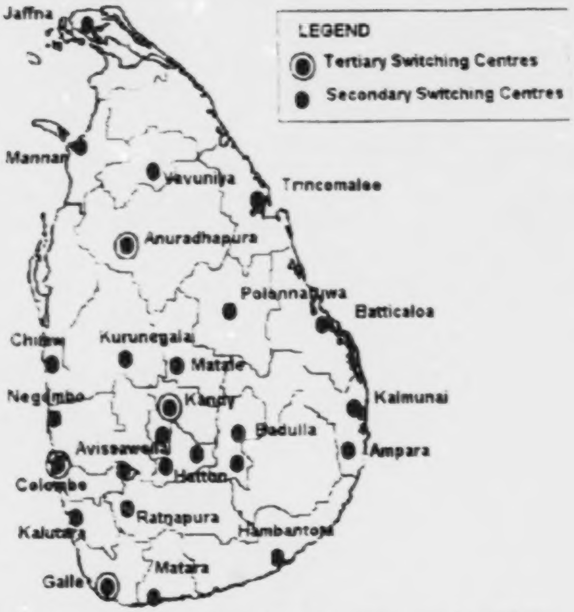

Jaffna
LEGEND
Tertiary Switching Centres
Secondary Switching Centres
Mannar
Vavuniya
Trincomalee
Anuradhapura
Polonnaruwa
Batticaloa
Chilaw
Kurunegala
Matale
Negombo
Kandy
Kalmunai
Badulla
Ampara
Avissawella
Colombo
Hatton
Kalutara
Ratnapura
Hambantota
Matara
Galle

Figure 1 : Sri Lanka map indicating important switching centers.

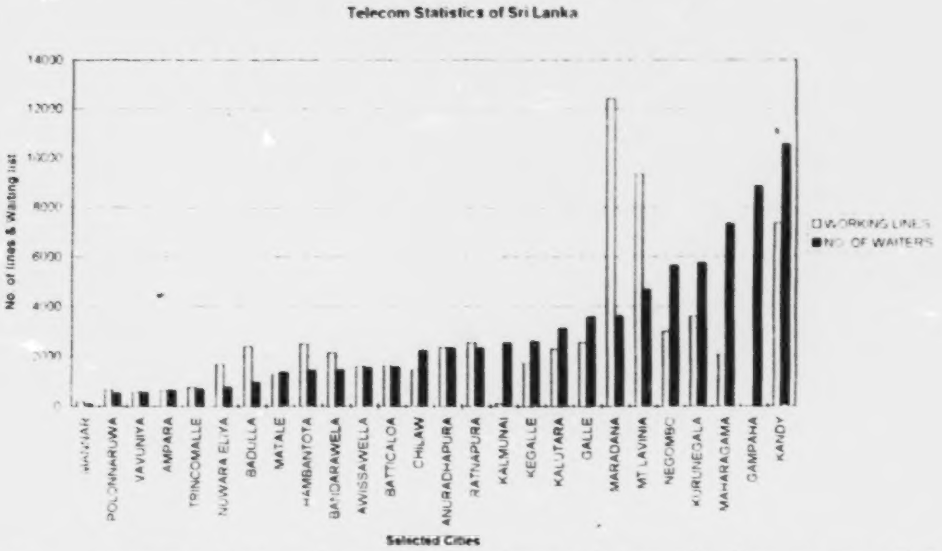


Figure 2 : Waiting list and available phones in particular areas of Sri Lanka

Table 1 : Paging Community

COMPANY	CUSTOMER BASE
Info com	3000+
Intercity	2000+
Equipment Traders	1500+
Fentons	500+
Bell communications	500+

Table 2: Possible growth Patterns

Target date	Low estimate	High estimate
December 1995	460,000	500,000
December 1998	560,000	750,000
December 2000	630,000	1,000,000

structure of production has changed markedly over the past decade, with industry and construction now accounting for 28% of GDP, services for 50% (significantly more, for example, than in India's) and agriculture 22%. The industrial and service sector are currently growing at around 5-6% per annum, which fuels the structural development which will sustain the growth of banking and finance, information - based activities and the telecommunications industry.

Sri Lanka's garment exports is less than 1% of total world exports as per 1992 statistics. However it accounted for 44.7% of the value of total exports of Sri Lanka. As per information collected by the authors, in surveys and discussions most garment industries in Sri Lanka welcome specialized telecom services which allow the transfer of designs with their buyers or joint venture partners in foreign countries. Further many new IT companies in Sri Lanka, who wish to access and exchange information with foreign counterparts wishes to have new data services and Internet access etc. This is quite evident from the fact that new telecom services provider, Lanka Internet Services has started Internet services on a commercial basis.

Many of the country's social indicators - e.g. life expectancy (72 years), currently population growth rate (1.1%), and primary and secondary education enrolment (100% and 75%) - are well above those typical for a country of Sri Lanka s level of income, which provide a good foundation for future growth. By international standards, Sri Lanka's distribution of ownership appears to be relatively broad, and its distribution of income resembles that of a far more developed country. However, the country's physical infrastructures - power, roads and telecommunications - are all in need of development, while the civil unrest of the last decade in the north and east of the country has left parts of the country, particularly the Jaffna Peninsular, almost totally without connection to the rest of the country. With the signs of government taking over the control of Jaffna peninsular, it shows signs of a major growth area for basic as well as value added telecom services.

The 1994 Sri Lanka Telecom services market is estimated at approximately $140 million, made up as follows; Sri Lanka Telecom-domestic & international PSTN-$ 120 million; Cellular operators-$ 17 million; Data network services-$ 3 million; Public pay phone services-Market just commenced. The total market represents approximately 1.4% of Sri Lanka s GDP, which is just below the average for Asia (1.5%). Internationally, country expenditures range from less than 1% upto 6-7%, depending on geography, level of development and economic focus. The world average is 1.8% and the vast majority of countries spend between 1% to 2%, though the proportion generally rises with income level and economic diversification. (the US and UK are 2.1% and 2.3% respectively).

Looking at world experience, there are several factors which contribute to a country spending a high share of its GDP on telecom, namely; small countries and island economies with a high percentage of their economies made up of export trade or tourism trade and countries which have a high immigrant/emigrant population and consequently high levels of international calling.

In view of the above, being a small country, island, export oriented, with a sizeable emigrant workforce, relatively large service sector (50% of GDP), and the recent policy of encouraging foreign investment and export industries through free trade zones, establishes Sri Lanka as a potential high user of telecom services. Hence it is estimated that Sri Lanka s telecom market should grow to over 2% of GDP over the next few years. When combined with projected GDP growth of 5 - 6%, a minimum compound growth of 14 - 15% per annum is expected in the telecom market. This would add approximately US $ 20 million to the annual market immediately, rising to an additional $ 135 - 150 million per year by the year 2,000.

6. CURRENT STATUS OF TELECOM SERVICES IN THE ISLAND

For a population of about 18 million, land line penetration is approximately 180,000 and the cellular subscribers are at an additional number of 35,000. The cellular community is fast growing and 3 analogue providers, Celltel, Mobitel and Call link, also are in a price war, offering various packages, is further aggravated due to the recent introduction of GSM services by the Maharaja group.

Rural and urban penetration in the country stands around 30% and 70% respectively. Subscriber waiting lists as per telecom statistics appears to be between 160,000 to 200,000. Figure 2 shows the waiting list distribution in the major areas.

The main reasons for the waiting list is due to : lack of competition; Low investment in the telecom outside plant; Governmental procedures related to procurement slowing down the expansion; Lack of sufficient exchange capacities; non - consideration of telecom services as a business (until recently) by the government owned telecom.

Being an Asian country who progressed into digitalization in the early 80s, today over 90% of the voice lines are serviced by digital exchanges and installed by Alcatel, AT&T, Nokia, NEC and Erricsson. Transmission equipment are supplied and installed by NEC, Nokia, Fujitsu, Alcatel, AT&T and Ericsson. Eventhough the SLT charges for installation of Wireless Local Loops are high around US$ 1000 compared to approximately US$ 200 - 300 per land line, wireless services provided by Sri Lanka Telecom (SLT) will soon reach beyond 7500 lines, serving special categories of subscribers. Motorola under a US$ 7 million contract is expected to install and deliver about new 6400 WLL systems for SLT by the end of 1995.

International traffic was routed via two SLT owned satellite earth stations, one analogue type 1A and one digital 1B type (transportable). 3rd digital earth station was recently commissioned and this will provide additional capacity. SEA-ME-WE cable system is also carrying part of the international traffic. International traffic is around 75 million minutes and this happens to be a growth of 10-12% over previous year (1993). The gateways are provided by 400 line Ericsson system and a 1000 line AT/T switch installed in metropolitan Colombo. SLT investment on submarine fiber is around 16 million US$ and the direct dialling facilities are available for 135 countries.

Low telecom penetration attributed to the reason that within the last 3 - 4 decades it was only the government department (which was later converted to a Corporation) which was providing the basic infrastructure for voice services. This process was always severely affected due to governmental rules, regulations and procurement procedures which always delays the infrastructure development. Even after deregulation in Sri Lanka, due to pressures from the employees of the Sri Lanka Telecom etc, the regulatory authorities were unable to issue licenses for voice eventhough the demand was there from the fast diversifying and growing private sector.

7. PRIVATE SECTOR PARTICIPATION

Over 35,000 cellular subscribers are services by four companies, namely

Celltel, Mobitel, Call link and Maharaja Telecom Network (MTN). GSM provider, MTN, is a very new entrant into the service and attempts to provide a wide coverage digital service making use of their own infrastructure under commissioning- Maharaja Telecom Tower Network (MTTN). Further details on activities of these companies are provided in Ref 1. Out of these companies, Mobitel, incorporated in 1993, is a subsidiary of Telstra corporation of Australia, had a considerable growth and entered a joint venture agreement with SLT recently, from its original BOT agreement. Just two years from the original agreement, SLT agreed to scrap the BOT agreement for a 40% share of Mobitel s ownership, where balance 60% will remain with OTC Australia.

However most low income groups, particularly the household are unable to bear the cellular phone costs, even though it is slowly becoming a fashion among the younger generation of the richer population.

Meanwhile two data and fax service providers, Datanet and Electrotek Network Services Limited are competing for the fast growing data service business. Out of these two , Electrotek was able to undertake many special projects (including R&D) to supply telecom products to SLT and to some regional countries. [Ref 5].

The Paging community is supported by 5 companies with nearly 8000 customers. Table 1 shows the approximate distribution among the five. Two phone card services are growing fast and Lanka Pay phone services owns a major share, compared to the late entrant Metrocard service.

8. RECENT TRENDS AND GOVERNMENT POLICIES

8.1 Government Objectives

In their yet unpublished telecom policy documents, the government is expected to reach the following objectives

a) To provide telecommunications facilities to all, at cost based tariffs.

b) To achieve universal service covering the whole country, including all villages.

c) To attain an acceptable quality of service for voice and data communications for both national and international communications.

d) To eliminate waiting lists for telecom facilities.

e) To provide prompt and effective attention to consumer complaints and improve public relations.

f) To progressively increase local value - addition in telecommunication projects, through local manufacture and construction at competitive price levels.

The defence, security and environmental interests of the country will be protected while meeting the above objectives.

8.2 Targets

The targets of the government related to POT services are:

a)Telephones to be made available on demand by 1998. .

b)To provide telephones, telegraph and facsimile access to all villages and villagers by 1998.

c)Performance of telephone service to be improved such that : the outage days per line to be made below one day per year on the average by 1997; All faults to be cleared within 24 hours and no faults to be kept outstanding for over 7 days by 1997; Call completion rate to be better than 45%

during peak traffic by 1997.

d)To improve the customer satisfaction by : providing prompt and effective attention to subscriber complaints by the end of 1995 ;Providing 24 hour efficient directory and inquiry services by the end of 1995, which will be computer assisted.

e)Contracts for major projects undertaken by the Government and its agencies will be packaged in a manner to encourage local construction as well as manufacture of some products commencing 1995. Progressive increase in the use of local products and local construction will be encouraged to reach a target proportion of 35% by 1998.

In keeping with the aspirations of the people and the demand arising from rapid economic growth , government s expectations for direct exchange lines will be in the order of magnitude as per Table 2. Currently a government owned company Sri Lanka Telecom Services (SLTS) is actively engaged in installing over 150,000 lines to be commissioned before December 1995. However these project targets may be slightly delayed due to practical reasons.

9. WIRELESS LOCAL LOOP (WLL) SERVICES

In order to attain the above targets, the government has decided to liberalize the WLL service by issuing two licenses to the private operators for an island wide service [Ref 4]. According to the economic statement of the government, a significant portion of the infrastructure investment effort will have to be undertaken by the private sector. As per documents [Ref 4] released by the authorities it envisages to be one of the steps towards this objective, especially since wireless services are mentioned in the National Telecommunications Policy as a field for private sector participation.

The terms and conditions of the license include special attention to the provisions of telecommunications services to the entire country, by providing both operators with two equal frequency bands, suitable for urban as well as rural areas. Furthermore the license fee structure is geared towards ensuring national coverage and service provisioning. Improved provision of services will contribute considerably to reducing waiting lists for telecom facilities. Together with SLT s efforts, the effect is expected to be sufficient to eliminate the existing waiting lists for telephones.

The bid consortium must satisfy the conditions - US$ 25 million equity capital, of which a minimum of 20% by the local partners, $100 million bank loan facility and Telecom expertise among others. License duration is 20 years and new WLL services licenses will not be issued until the end of 1998. Furthermore, new WLL licenses will not be issued until year 2,000 if a specific growth pattern is maintained. International services are not included in the license but interconnection to SLT, which is a licensed international operator, will be arranged.

10. ENTRY OF OTHER PRIVATE OPERATORS WITH STRATEGIC ALLIANCES

Meanwhile, with the WLL tender announcement and the potential for data services, many successful business conglomerates in Sri Lanka are getting ready to enter this lucrative wave of business, via strategic alliances. One such new company is CeyCom Global Communications (Pvt) Ltd, under Ceylinco Group. The company plans to establish a data network using VSATS via a strategic partnership with the COMSAT RSI, a subsidiary of COMSAT in USA. The details of the project is as per Ref 6. At the time of finalizing this paper CeyCom Global Communications and COMSAT RSI have signed the joint venture agreement and the equipment contracts. Further government has

issued a license to CeyCom for VSAT based value added services.
The project based on VSAT technology, is expected to provide the following specialized services, with an immediate investment of over US$ 3 million, growing towards 15 million in the next 5 years.

Low bit rate Voice Calling Service (LBRV)
Electronic Messaging Service (EMS)
Packet Data Transfer Service (PDTS)
Public Switched Data Network Service (PSDN)
Private Switched Data Network Services (PVDN)
On-line Transaction Processing Services (OLTP)
Electronic Funds Transfer / Point of Sale (EFT/POS)
Electronic Data / Document Interchange (EDI)
Freeze Frame Video Image Transfer Service (FFVI)
Closed circuit Television Monitoring Service (CCTV)
Slow Scan Video Communication Service(SSVC)
Video Conference Centre Service (VCCS)
Video Desktop - to - Desktop communication service (VDDC)
Video Broadcast Business & Educational Service (VBBE)
Facsimile Transmission/Reception Group 3 service (FAX3)
Facsimile Group 4 service (FAX4)
Graphic image (two dimensional) transfer Service (GITS)
Desktop - to - Desktop Interactive Graphics Service (DDIG)

The company is planning to enter the WLL tender competition with suitable other strategic partnerships.

11. CONCLUSION

The last 2 years have generated a serious interest in the telecom service area, as a business proposition, particularly among many private companies and this may certainly help the Sri Lankan government achieve its ambitious targets.

References

1. A. D. V. N. Kularatna: "Contribution by the operators of private telecommunication services towards development telecommunication infrastructure of Sri Lanka in the recent past", PTC '94 proceedings,pp 415-419

2. Sri Lanka Central Bank: " Economic Survey - The first half '94"

3. Ceylon Daily News: " Telecom and Mobitel in joint venture"; 22 May 1995

4. Ministry of Posts & Telecommunications, Sri Lanka: "Issue of Licenses for providing telephone service using digital Wireless Local Loop Technology"; [Tender document released - 28th March,1995]

5. A. D. V. N. Kularatna et al : " Utilization of developing country resources for research and development related to telecommunication products and systems"; PTC'93 proceedings, pp 866-873

6. A. D. V. N. Kularatna, G. Gunawardana & C. William: Value added services & private sector investment in new telecom projects in Sri Lanka"; PTC'95 as proceedings, pp 440-444.

The Information Infrastructure: The Key to Precision Marketing for a Competitive Telecommunications Industry

Dr. Sandra B. Cook
San Francisco Consulting Group
San Francisco, California U.S.A.

1. ABSTRACT

In the increasingly competitive environment of the convergence, the communications service providers that succeed will be those that leverage an understanding of customers to deliver highly individualized products, services, and levels of customer care that precisely meet customers' needs in every market. The unprecedented level of knowledge about customers that is required can be achieved through "precision-" or "micro-" marketing.

Because of their experience in collecting data and information on customers, telephone companies are indeed well positioned to excel at precision marketing and could potentially use it to maintain a central role in the new environment. However, this advantage has not yet been fully realized or leveraged. This paper will discuss the sources of customer information that a telephone company possesses and suggest how it could exploit this and other information to secure a premier position in the convergence.

2. INTRODUCTION

The global telecommunications industry is in a state of explosion and upheaval. Telecommunications markets around the world are being liberalized, and, as a result, traditional telephone companies are facing the challenges associated with new competition in their core businesses while simultaneously attempting to enter new markets. This is complicated by the fact that, in the environment of "convergence" (the fusion of telephones, television, and computers), competition is increasing at an unprecedented rate. The range of suppliers from whom customers can choose will expand far beyond the traditional telephone companies. Customers who were formerly forced to subscribe to a monopoly service will be able to choose from a variety of telecommunications service providers (TSPs) that encompasses traditional telephone companies, cable television companies, wireless telecommunications carriers, entertainment and software businesses, utilities and railroads, satellite-based carriers, and others. Furthermore, many of these providers may be involved in the process of jointly supplying what is, from a customer's point of view, a single event or service.

With the increased range of choices that will result from the onslaught of competition in this convergence, customers will become more critical of suppliers. In short, customers will want to be in the driver's seat — they will want to call the shots.

Thus, with the blurring and shifting of roles of the various players, those that will be successful and achieve significant market share will be those that understand and meet the needs of their customers best. They will be the providers that know which customers to target for acquisition and retention, which customers they can lose profitably, and — for those customers that are retained — which products and services should be offered in order to secure customer loyalty and stimulate their usage of communications services.

With areas of opportunity and vulnerability being defined by services and market segments, carriers will be forced to understand their customers' needs and expectations with a unique degree of intimacy. In fact, it could be said that the telecom industry will be driven by "customer intimacy." Customers will have to be pursued, attracted, and retained with highly customized products, services, and customer care that precisely meet their needs. And even if several entities are involved in the delivery of a service, the customer must be faced and managed in a way that is singular, unified, and not confusing.

These drivers will compel carriers to place increased emphasis on marketing and to achieve an unprecedented level of knowledge about their customers and an understanding of customers' needs at the most fundamental level. As this suggests, the emphasis must be on an extremely detailed level of customer information. The terms commonly used to refer to this fine-grained approach to understanding customers' needs include "precision marketing," "micromarketing," "one-to-one marketing," and "database marketing."

And because all of this customization and precision marketing will have to be executed in a cost-effective way, it will require mass-customization and automation.

Telephone companies are well positioned to maintain a central role in the new environment characterized by convergence. Through the exploitation of their extensive information infrastructures and because of their experience in collecting data and information on customers, telephone companies have the potential to excel at precision marketing and to secure a premier position in the new environment.

However, this advantage has not yet been fully realized nor has it been leveraged by telephone companies. This is because some of the most important information resources of telephone companies are not yet recognized as capable of supporting marketing-related applications, nor are they well-architected for these. The telecommunications billing system is a prime example of this point.

3. THE TELECOMMUNICATIONS BILLING SYSTEM AS THE CARRIER'S PRECISION MARKETING MACHINE

The telecommunications billing system can be seen as a key element of the information infrastructure for a TSP and one that is pivotal in meeting a company's need for precision marketing. Because of the wealth of data it accesses, the billing system can serve as a source of information that can be used in determining and meeting customers' precise preferences and needs. The billing system can also be seen as an enabler for mass-customization, as billing-related information is present in machine-readable form and can thereby be used readily in other automated systems. Viewed this way, and because this approach to understanding and analyzing information about customers involves the automated processing of huge quantities of data, the billing system can also be a critical resource for what is coming to be known as database marketing.

That the billing system could play such a role may not seem obvious at first. After all, we typically think of the billing system as an "invoicing machine," whereas what is being suggested here is that it could function as a "precision marketing machine." However, while the telecommunications billing system has not traditionally been seen as playing such a role (i.e., precision marketing), in fact there is precedent for it in other industries. For example, General Motors went into the credit card business not just to build loyalty and offer cardholders rebates on cars, but also because it saw the credit card billing process as a way to harvest reams of data about consumers.

Similarly, in telecommunications firms, the billing system is rich with customer information that will enable the most finely grained segmentation, that can support customers segmentation down to the subsegment, and that will reveal what customers really want. While there are many associated analyses and activities that can be based on billing data, only a few of these uses are discussed here for illustrative purposes. They include customer segmentation; product definition; target marketing, sales, and promotion; support for sales and account management; customer retention analysis and customer care; and product and promotion tracking. These are described in turn below.

3.1. CUSTOMER SEGMENTATION

Billing data can be put to valuable use in customer segmentation. For example, residential accounts can be segmented by the amount of money that they spend, the number and types of products that they buy, and how long they have been at their current location. Some of the descriptive terms used to denote such segments by an RBOC in the United States include:

- "Big spenders" — customers who purchase a large number of products and who have high spending levels
- "Movers and shakers" — customers who move frequently, resulting in high levels of service order activity and/or potential collection problems
- "Stayers and payers" — customers who remain in one place, pay their bills on time, and are relatively uninterested in new products and services.

However, segmentation to a much finer level than indicated above is possible using billing data. Billing data can be used to zero in on ever smaller niches of the population, ultimately aiming for the smallest consumer segment of all: the individual. Segmentation can also be approached through determination of usage patterns (i.e., volume; local, national, and international distribution; day-of-week, time-of-day, and seasonal distribution) and correlation with demographic data for consumers and with business statistical data for business customers.

- For instance, the financial services industry has a strong community of interest with other financial centers in the world, and time-of-day distribution will reflect local times in these centers.
- A telecommuter subsegment can be identified from, for instance, long daytime calls.
- Seasonality will be reflected in some subsegments (such as the distinct, abrupt changes in usage at colleges and universities).

Such segmentation, which can be achieved only through effective analysis of usage patterns, is critical to the development of products and pricing plans specific to given market segments or subsegments. This is discussed further in the next section.

3.2. PRODUCT DEFINITION

Another valuable use of billing data is product definition. For example, call detail records, including attributes such as who calls whom, time of day, etc., will be very useful in developing call discount plans. Other key information that could be derived from the call detail records includes community of interest for the business (i.e., who its customers and suppliers are).

Based on such information, packages could be defined and offered to groups within an affinity relationship, such as hospitals with clinics, that would include a package of voice, data, fax, and credit-card verification. These could be viewed as "quasi-ISDN" applications; businesses could be sold a bandwidth package rather than a usage package. There could also be a package of services targeted at small retailers. This might include a readyline 800 that terminates to a number that could be used for other services; a standby line or alternative measured line to pick up overflow traffic, tax, and credit card verification.

3.3. TARGET MARKETING, SALES, AND PROMOTION

Billing data could be used in target marketing to determine what sorts of products would be useful to which customers and — taking this idea further — to ensure that the appropriate customers know about these products. In the first instance, an extremely useful set of billing information is the usage growth rate of a customer. This is very important for some products, such as CENTREX. Growth rates are also indicators for customers likely to be interested in new products or services or for expanding the localities where products and services can be deployed. Using this data, a carrier can determine what sorts of products would be useful to certain customers. In the second instance, detecting what sorts of offers would be appealing to which customers and printing notices of those products, sales, or promotions on a statement has come to be known as "relationship billing" and has been rolled out for American Express in Europe, Canada, and Mexico. It has been so successful that, next year, AmEx plans to introduce relationship billing in its biggest market, the United States.

One of the highest expenses of doing business is customer acquisition, or sales expense. By analyzing the success of sales to specific market segments, carriers can identify the profile of customers most likely to respond to a particular product feature set, or companion product (such as custom-calling features that seem to be successful when sold in conjunction with another product), and use this information to target sales efforts. Also, the carrier needs to be able to target existing customers for add-on sale of options and companion products and to identify the most likely new-customer profiles. Indeed, for existing customers, there should be a natural progression of ongoing follow-on sales (for example, following up sales of a basic custom-calling feature with contact presenting more advanced features). These opportunities can be pinpointed by examining billing data.

Performance of target marketing and sales requires analysis of all usage data, including uncompleted calls (due to a busy line or an unanswered call). For example, customers with completion ratios below a certain threshold may be candidates for value-added services, such as voicemail and call waiting.

3.4. SUPPORT FOR SALES AND ACCOUNT MANAGEMENT

Using billing data, customer care employees could be supplied with information about customers that would enable the employee to suggest appropriate new products and services for the customer. (For example, if the customer is working from home, the customer care employee could suggest a second line to support fax services.)

Such information could come from a merge of billing data (what products the customer is currently purchasing and using) together with information from other sources, such as demographics and psychographics that are gathered by other customer care employees or found in purchased databases (e.g., catalogue mailing lists, National Demographics & Lifestyles Inc., research houses).

- Among the sources of demographic information that are useful relative to business customers are Dunn and Bradstreet for information about business locations and subsidiary relationships, Equifax and TRW for credit information, and Computer Intelligence for information about numbers and types of technologies, including data centers, number of fax machines, PCs, etc.
- Other interesting demographic details may be gleaned from customers' responses to promotions, and for businesses, what functions they perform at different locations.
- Some data about customers is captured directly by customer care personnel. Micromarketing for the business segment involves capturing information directly from the customer that is unique and useful to the company.

Based on a merge of billing and demographic data, a customer care representative might suggest a teen line to a residential customer, or suggest a medical information search service to the caregiver of an elderly or ill person in the home.

Billing data can also be used to point to styles and levels of account management that ought to be applied. Again, using the example of information about customer growth rate, a relatively flat rate of growth suggests a stable company. Such companies tend to purchase the same products and services repeatedly. These should be account-managed less intensively than those that are growing and which are, therefore, more open to further purchase opportunities.

3.5. CUSTOMER RETENTION ANALYSIS AND CUSTOMER CARE

Carrier profitability is dramatically affected by customer retention. In fact, studies show that it costs four to five times as much to acquire a new customer than it does to keep a current one. Furthermore, retained customers not only cost less to service but tend to buy more services. Clearly, customer loyalty is a key economic factor for all businesses.

The billing system can assist in the analysis required to spot high-margin customers, the ability of the carrier to retain these customers, and customer care that will be both appropriate and required to sustain ongoing customer relationships.

Customer segment margin analysis enables a carrier to see the profitability of the segment over an extended period of time rather than the profitability of individual products. Product margin analysis on its own is incomplete and can be misleading. A product that doesn't appear to meet margin requirements may be, in fact, an important companion to a very profitable product.

Customer retention analysis assists in identifying problem areas, such as market segments by geographic area and products with unreasonably high incidence of churn. Armed with this analysis, carriers can put into effect corrective retention programs (e.g., product reengineering, revised pricing plans, etc.).

Trouble reporting and fault analysis provide carriers with key assistance in the customer care function. A high degree of troubles/faults reported by a customer should be treated as an early warning of potentially losing the customer. By correlating trouble reports to actual revenue being realized, the carrier can prioritize trouble resolution for highly valued customers.

3.6. PRODUCT AND PROMOTION TRACKING

Information in the billing system can be used to track new products and promotions. A carrier tracks new product usage to determine the effectiveness of sales programs, for which customer segments the product is most successful, and how the product is being used (usage patterns and volume). It is important that this tracking can be done daily so that carriers can adjust sales programs to be sure they are cost effective.

Promotions, likewise, need to be tracked. Here, time is more critical, as promotions are usually of short duration. It is important to verify that the promotion is generating the desired response and that it has not become too successful (e.g., that it creates grade-of-service problems).

It is also necessary to track new products by customer segment/profile. It is important to track product quality/performance in the critical period following introduction. If the market requirement for the product or the method of sales has been incorrectly defined, it is necessary to catch this and make adjustments early.

4. THE BILLING SYSTEM AS AN AUTOMATED TOOL FOR MASS CUSTOMIZATION

Because the personalized approach to customers must be achieved in a cost-effective manner, it will require mass customization. Mass customization refers to the production of varied and individually tailored products at the low cost of standardized, mass-produced goods. It is critical when products and services are constantly changing in response to what each customer wants and needs and what competitors are doing.

The billing system can be seen as the source for mass customization and micromarketing (see Figure 1). Clearly, this will involve automation. By downloading billing data into corporate databases and using specially developed tools, sophisticated users are able to analyze customer data by assembling all sub-accounts of a given customer, aggregating spending, determining the types of products purchased, and determining selling strategies to that account. Using this analysis, users have also been able to identify contractual services that were being billed improperly, both over- and under-billing.

There are several technical methods available for this purpose. In several U.S. RBOCs, data for segmentation and other marketing purposes is captured today from downloads of the master files from the billing and other systems into a special computer to be stored as the "corporate data warehouse" (CDW). A variety of CDW approaches are currently available. While they are not the topic of this paper, they are mentioned here to suggest the value of billing data for automated analysis of customer-related data.

5. COMPLETING THE TRANSITION FROM INVOICING MACHINE TO PRECISION MARKETING MACHINE

Most major carriers are realizing the implications of these marketing and similar business drivers and are responding to the challenges through major investments in billing and customer contact systems. The investments being made are huge, but they are largely in traditional, or "core," areas of billing functionality.

However, another wave of investment may be required because the untapped (but absolutely necessary) role of the billing system of the future is in marketing, along the lines described above. Investment is required because despite this potential, today's billing systems are not designed or built to support the requirements of mass customization and precision marketing. Traditional support systems designed as invoicing machines for regulated monopolies are usually inadequate in today's competitive environment in several ways. They often do not:

- Support ongoing market analysis, product development, and the tailoring of promotion and advertisement to customers

Billing System Characteristics	***Dimensions of Mass-Customization Supported***
Billing system data can be . . .	. . . the basis for needs-based subsegmentation
Billing data and pricing capabilities can be . . .	. . . the basis for product definition
Billing system pricing capabilities can enable . . .	. . . the rapid introduction of highly customized products and services
The billing system is comprised of extensive customer databases and communications networks that allow "everyone" to view customer information simultaneously . . .	. . . thus improving chances of acting on unique segmentation and rapid product deployment.

Figure 1

- Take advantage of sales opportunities that exist in every customer contact
- Support proactive customer care
- Provide adequate account activity measures through invoicing
- Support good customer relations
- Support management's needs for the information necessary to run a competitive business

In short, these systems were developed as a back-office function, not as the integral part of modern telecommunications product and service offerings that they must become. The transition from systems designed for a monopoly environment to those geared to a competitive one is extremely critical to a carrier's future success in the convergence.

For billing systems to deliver on their potential to support precision marketing, a new applications architecture is required. The new architecture must support:

- Unique customer-service needs for multiple segments
- The ability to anticipate the needs of customers
- The ability to turn every customer contact into a sales opportunity
- Flexible pricing and discounting
- Rapid introduction of products and services
- Flexible billing information products
- Flexible inter-connect and inter-business agreements
- The strategic, marketing, and operational information requirements of the business.

Until new billing systems can be defined and implemented, a telecommunications firm must gain an understanding of precision marketing, its central role in success in the convergence, and the requirements this places on the telecommunications information infrastructure. Armed with this knowledge and using it to define and procure strategic, next-generation systems, telephone companies will be able to secure premier positions in the era of global competition and convergence.

The Strategic Importance of Data Warehousing in a De-regulated Telecommunications Market

Primary Author: Denis Tossan, Director, Telecoms Industry, Oracle Asia Pacific, Hong Kong.

Co-Authors: Leigh Baker, Sr. Director, Business Development, Telecoms Industry, Oracle Asia Pacific, Melbourne, Australia.
Keith Budge, Director, Telecoms Industry, Oracle Asia Pacific, Singapore.

Telecommunications Industry Group
Oracle Corporation, Asia Pacific Division

1. INTRODUCTION

1.1 Overview

Access to customer information and especially, detailed customer behavior information, is critical to competing effectively and to operating profitably in a de-regulated and competitive telecoms environment. This is true for both incumbent carriers and for the large number of new operators entering the Asia Pacific market.

Data Warehouse presents telecommunications operators with a solution to the problem of intelligent access to data that may reside in a number of often disparate computer systems and that is, almost by definition, vast in quantity. It provides a single, consistent view of customer and operational information for reporting, management decision-support and strategic business analysis.

This paper examines the market context of the problem faced by telecoms operators and lays the foundations for the data warehouse solution path. It provides definitions, describes key attributes and data warehouse technologies, and proposes the place of the data warehouse in the future systems architectures. It discusses the key steps and critical success factors in data warehouse implementation and presents case studies from a number of telecoms operators.

The objectives of the paper is to highlight to senior management that data warehouse is an essential strategic weapon, not just another technology. The speakers bring to this topic the leading technology and expertise of Oracle Corporation and experience in working with senior management of both incumbent and new telecoms operators throughout the Asia Pacific region and other parts of the world in building competitive information systems.

1.2 The Impact of De-regulation and Convergence

The magnitude of change in the communications industry is staggering. With advancing technologies, the boundaries between wireline, wireless, voice, data and video are blurring. Telephony, cable and satellite are converge. Computers and phones will meld. And a dramatic catapult into the advanced information age is taking place. Nowhere is this more likely to happen than in Asia Pacific, a region which is seeing much faster growth in per capita income and affluence than most parts of the world. Asia Pacific has not been saddled by old technology and legacy systems, and with a projected capital investment of US $300 billion in communications infrastructure between now and 2000, is poised to leapfrog into the most advanced networks and communications services the world has to offer, bypassing a whole generation of intermediate technology.

The opportunities in Asia Pacific have not gone unnoticed by the top operators around the world. US and European carriers have accelerated their expansion programs into the region by providing international value added services, forming alliances with regional carriers and taking part in bidding for the large number of new telecommunications licenses being issued.

The consequence of all this? There will be a fundamental change in the competitive landscape. Competition will rapidly extend beyond country and regional boundaries to be truly global. And operators will need a much bigger market to survive.

In this landscape, carriers must intimately understand customers needs; offer highly customized products and services; build rapid change and flexibility into their offerings; tailor prices to individuals; and go to market in days or weeks, not months and seasons.

1.3 The Need for a Market-based Strategy

As de-regulation sweeps across the globe and competition picks up, it is not enough for operators to just hone up on time-to-market, price, product and service. To be sure, these are all important. But alas, they can be easily duplicated by the competition. Ultimately, information - and knowledge - is the only sustainable competitive advantage.

With information, you can answer questions like:

- Who are my best customers?
- What is the churn rate by segment? By product?
- Which customers do I want to lose?
- What is the profit margin by product, service, geography?
- Which customers to target for which campaign?
- What is the expected penetration of a new campaign?

1.4 The Problems with Current Systems

Existing business systems are transaction oriented. Older systems tend to be based on rigid or proprietary technology. These systems are not designed for strategic decision making. Thus, a lot of the company data is locked up in the computers but are very hard for users to get at. Often, the disparate systems contain incompatible and inconsistent data, and do not provide a unified view of customer and product information. They mostly contain current or summary data, rarely contain competitor and market data, and most certainly do not have sufficient detail for critical analysis. They provide limited ability to discern usage patterns and emerging behavior trends. In sum, transaction processing systems have limited capability for supporting business analysis and competitive marketing.

1.5 The Solution Path

What is needed is an architecture for change. An architecture which allows the operator to handle things they don't know about yet and be able to do so quickly. The writers proposes such an architecture, anchored by a Data Warehouse, which contains the data needed to answer questions for management decision making without being encumbered by the problems of legacy and operational systems.

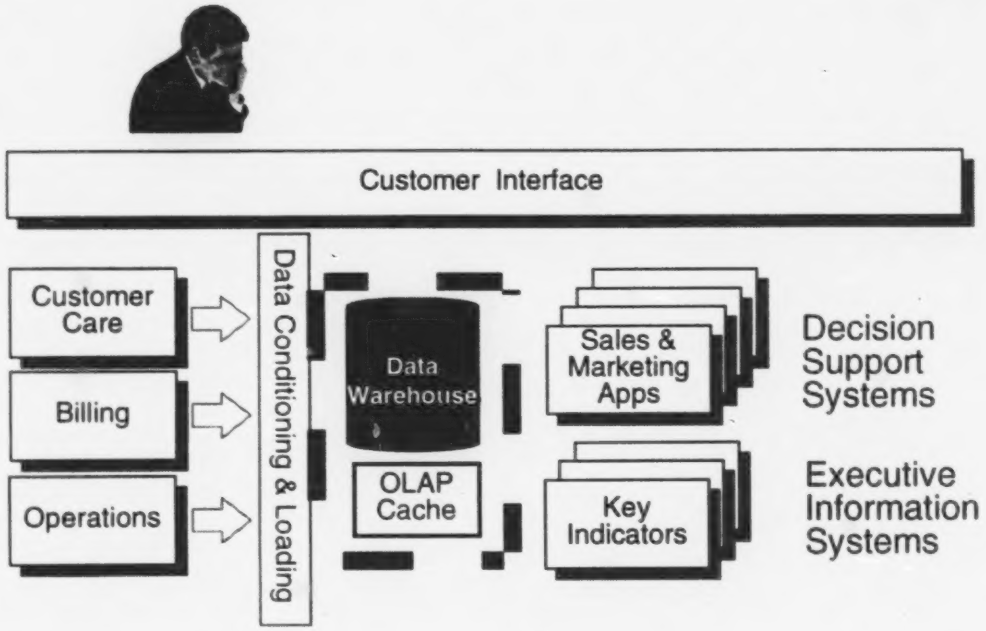


Figure 1 - An Architecture for Change

In this architecture, operational systems continue to focus on transaction processing, delivering reliability and performance. They feed the Data Warehouse with relevant information on a periodic basis. The Data Warehouse is separate, thus ensuring that decision support activities will not adversely contend with transaction processing. At the same time, the Data Warehouse is designed to provide maximum flexibility for analysis and decision making, and support the retrieval of any level of information by any level of user or management in the organization. Thus the organization is empowered with a consistent, flexible and powerful information engine.

2. DATA WAREHOUSE ATTRIBUTES AND TECHNOLOGIES

2.1 The Data Warehouse Market Momentum

Data Warehousing is the latest and fastest growing trend in information systems. According to a META Group survey in the US in 1995, many Fortune 1000 class organizations are beyond the experimental stage and are investing considerably in Data Warehouse projects:

- 29% plan to spend US$1-3 million

90% will have a Data Warehouse within 18 months
Market surveys also show that Oracle has the lion share of Data Warehouses installed, and is expected to continue to dominate this market because of its advanced parallel processing technology and it's strong support and consulting capability for these very large database projects.

2.2 Definition of A Data Warehouse

As the marketplace for Data Warehouse systems expand, the definition of just what is a Data Warehouse becomes more fragmented depending on which vendor or analyst is doing the defining. At Oracle, the definition embraces what the analysts prescribe, what Oracle customers are doing, and most importantly, what the businesses intend to do in the future.

Accordingly, **a Data Warehouse is:**

> **A strategic collection of all types of data in support of decision-making process of all levels of an enterprise. The Data Warehouse should be capable of Any Data Source, Any Information Type and Any Access.**

Put another way, a Data Warehouse is an integrated database containing a history of detailed data which supports business analysis and can provide answers to unanticipated questions.

2.3 Components of a Data Warehouse

For purposes of our discussion the prototypical Data Warehouse is illustrated as having four major components.

Basically, data is selected from various data sources, run through the transformation and integration process to convert it to useful information, and loaded into the Data Warehouse where it is easily understood and accessed by knowledge workers using a wide array of graphical interface (GUI) tools.

2.4 What Data should be in the Data Warehouse

2.4.1 Integration of Disparate Data Sources and Data Types

These include:

- Pieces of data about customers, products, services, inventory, finance, transactions etc. which are spread out over many systems in the typical organization.
- External data about the market, the competition, the weather, census, subscription, credit and other demographic data etc.
- New sources like textual data, spatial data, news feeds and multimedia libraries. Spatial data make possible innovative applications based on location proxity. Multimedia data can provide high impact for learning and selling.

The integration of these diverse sources provide a holistic view of information. Correlating external data with company data can provide a powerful understanding of the impact of outside forces, thus allowing strategies to leverage or mitigate their impact.

2.4.2 The Need for Detailed and History Data

Summary data provides answers to a specific anticipated questions, and fine grain analysis is not possible. Detail data, on the other hand, gives the most flexibility for answering many questions. An example of detailed data is the Call Data Record from the switch. Historical data allows trends to be discovered and comparisons made.

2.4.3 Data Structures within the Data Warehouse

It is not only possible to have summarized data in the Data Warehouse, in fact it is recommended!

While the bulk of the data is detailed data, some data is lightly summarized and other may be highly summarized. Summarized data provides quick access to repetitive reporting information. Older data yet may be archived to cheaper media such as tape or CD-ROM.

2.5 Technologies

2.5.1 Critical Systems Technologies

The Data Warehouse is almost always a very large data base (VLDB). It ranges from a few dozen Gigabytes (billions of characters) to several Terabytes (thousands of billions), with a tendency to grow rapidly in size. This places special demands on the technology to accommodate, process and manage the data. Especially critical is parallel database software and parallel hardware based on cheap commodity components.

Parallel Database software must automatically split data base operations into many parallel and concurrent processes thus allowing queries to run in minutes or hours what would otherwise take days or be impractical using conventional or mainframe technology.

Data base operations which must be parallelized include searching, summarizing, joining, indexing, drill down, loading, backup and recovery, to name a few. The better the database technology, the more types of operations it can parallelize and the smarter it devises access strategies to automatically deliver top performance. While this is easy to say, the fact is that it has taken many years to refine this technology. Oracle is generally regarded by the industry as having the best "parallel everything" technology. For example, Oracle7 uses techniques like Star Query and Bit-mapped Index which are able to run complex data mining queries 10 to 300 times faster than other approaches. Equally important is a super fast database loading. For example, Pac Bell, which is building a Data Warehouse on Oracle, has 200 million call data records per month. Oracle7 has the fastest load performance in the industry.

Parallel hardware based on commodity components and open systems is very important. Fault resilience is a necessary hardware attribute for the Data Warehouse because no one wants to have Terabytes of data down when a component fails. High-end vendors like HP, DEC, Pyramid, Sequent and IBM have installed most of the hardware for open Data Warehouses.

Systems Management Software for VLDB is also important. These are supplied by the database vendors, hardware companies and various third party software houses. For the Data Warehouse, specialized software is available for source data preparation, matching, mapping and data modeling.

Data Warehouse users are discovering that vendor support is critical, as the Data Warehouse tends to stretch the limits of the technology due the size of the data base and the complexity of data mining queries. Moreover, the Data Warehouse is becoming recognized as strategic to the organization. Thus, it is critically important to choose a database vendor who can provide strategic, long term support.

While the Data Warehouse project is not chiefly a technical exercise, technology and vendor support are very important. For the considerations given, Oracle is regarded as the premier Data Warehouse choice, and command the majority share of this important market.

2.5.2 User Tools

The payback of the Data Warehouse is to allow users in the line of decision making to access the information themselves. Very important are the many types of tools needed by a diverse range of users. For example, users may range from knowledge workers doing specialized analysis across products or geographies to customer service reps requesting quick snapshots of individual customer profiles. Executives are another class of user. Often, they tend to focus on summary information and key indicators using EIS (Executive Information System) tools and purpose-built applications.

Different types of tools are useful, including tools for ad hoc inquiry, visualization, drill down and Online Line Analytical Processing (OLAP), multi-dimension or spatial analysis, statistical analysis, and contextual analysis.

3. STRATEGIC DATA WAREHOUSE APPLICATIONS AND CASE EXAMPLES

In general, the best business areas for Data Warehouse applications are Customer Information Systems, Marketing, Finance and Sales. Examples of Data Warehouse applications include:

Market Analysis
Customer Segmentation
Product Usage Analysis
Market Demand Analysis
Sales Channel Analysis
Customer Profitability
Vulnerability Analysis

Pricing
Discount Plan Creation
Margin and Yield Analysis
Competitive Price Analysis
Price Elasticity Analysis
Product Profitability
Call Plan Analysis

Sales & Service Negotiation
Lead Generation
Prospect Qualification
Campaign Management
Price Quote
Winback Programs
Sales Forecasting

In addition, there is a category called **Executive Information** which provide vital overview and key indicators for the general management of the business. Executive Information should be provided by the Data Warehouse, thus ensuring that summary information is consistent with detail data across all levels of the organization.

3.1 Categorizing High Payback Applications

User experience suggest a correlation between data intensity and competitive advantage. In general, the strategic, high payback applications tend to involve large Data Warehouse.

Based on experience to date, the highest payback Data Warehouse applications in the telecommunications industry are:

- Customer profiling and segmentation
- Customer demand forecasting
- Micro-marketing
- Product and customer profitability analysis
- Customer billing

3.2 Profiling and Market Segmentation - Mining for Customer Groups

Using the Data Warehouse to profile customers and segment them into groups with similar propensities can provide a powerful basis for database marketing. In segmentation analysis customer demographic, psychographic, and product usage information are correlated to identify and categorize behavior groups.

Thus, segmentation analysis may not only confirm, for example, the tendency of immigrants in general to make international calls, but may quantify which subgroups with what backgrounds tend to call which cities how often. This may allow several price plans to be devised to target the different segments.

3.3 OLAP and Multi-Dimension Analysis - Analyzing Intuitively

On-line Analytic Processing (OLAP) is providing business analysis capability to end users. OLAP typically involves complex processing of much data, usually in read-mode, in contrast to transaction processing, which involves little data, typically in update mode and with an emphasis on response time.

Multi-dimension technology is the critical user-friendly technology for OLAP. Multi-dimension analysis provides the ability to analyze information much more intuitively. The human mind tends to think in multi-dimension terms - for example, sales by product, by market by time period is a three dimension view. Multi-dimension tools allow different dimensions to be added easily and allow the information to be looked at from different perspectives, a technique call pivoting. Thus we may look at sales by product and geography, or vice versa, and then zoom in by market segment, total billing or time of day. Using multi-dimension analysis, a market analyst can better understand consumer preferences in different locations or spot emerging trends.

3.4 Example - Multi-Dimension Analysis for Target Marketing

For one telephone company trying to more effectively manage its marketing resources, it was not enough to merely segment the customers on only one level such as products. This company needed to know where the customers were located who subscribed to certain products and were known to be not only high spenders but also profitable. The data used for these questions included revenues, costs, payment history, demographics, products, and others.

This multi-dimensional analysis was not planned, designed and coded as an application. Had it been it would not have passed even the first change of direction. It was instead carried out as a series of analytical steps selected by the marketing user who was directly accessing the information.

Through looking at cross-sections of customers and flexibly directing and redirecting the next queries, customers were identified who showed a likelihood to consume products and services that make money. Additional dimensions were also added to identify the most effective advertising channel.

3.5 Correlating Disparate Data - Stitching Together Intelligence

As discussed earlier, correlating multiple sources of internal data and external data can be very powerful. With a Data Warehouse, a more comprehensive data model can be easily implemented to reflect how the organization wants to see it's business. Thus, the data model may support the notion of membership - as in the departments, branches and subsidiaries of a large organization, or in the members of a household. This allows, for example, a telephone company to form campaigns to target second line service and other calling plans to the different types of households. Another example may be to sell different Bill Summarization products to the different levels of large companies.

3.6 Example - Campaign to Promote the Second Line

In a competitive market where service providers are rapidly introducing promotions to sell new products and win customers, the cost of marketing can be expensive. The data warehouse may be used to systematically formulate a high scoring campaign thru correlating history data and external data.

The following illustrate the steps which may be used to promote and sell a product, like, for example, Second Line:

1. Stratify the existing users of the product and profile the highest usage customers to determine what they have in common - income, education, family size, computer or fax, minutes by time of day, and segmentation code etc.
2. Profile adopters before and after they purchased the product using historical data.
3. Profile those who retained the product versus those who did not.
4. Determine what these profiles have in common and how they differ.
5. Score prospective customers based on their resemblance to the successful users.
6. Develop a market strategy and promotion campaign based on the analysis
7. Track the results during and after the promotion to determine the effectiveness of the campaign.
8. Refine the promotional campaign and targeting algorithms for improvement.
9. Develop gains charts to determine the optimal level of marketing for the promotion.

The power of the Data Warehouse comes from its flexibility. Historically, applications have been developed which answer very specific questions. These applications quickly lose their value when the question changes or, more importantly, when another dimension is added to the question

3.7 Example - Calling Card

Calling cards also get a lot of focus. Most telephone companies know very little about their calling card customers. Who has them and uses them often? Who has them and never uses them? Who do not have them at all? What are the characteristics of the high volume users that also appear in some of the non-card-holders that equate to leverage points for high probability of a successful service offering? What call plans could be packaged with each calling card to impress that particular customer? These are questions that current information warehouse users can ask directly.

4. HOW TO IMPLEMENT A DATA WAREHOUSE

4.1 Difference Between Building a Data Warehouse and a Transaction System

In a number of significant ways, the Data Warehouse project is quite different from typical application development projects mounted by Information Technology staff. There are several reasons for this difference. Perhaps the most important reasons are:

- The Data Warehouse must be architected to answer future questions, not just current questions. In contrast, traditional applications deals with currently known and definable transactions.

- The Data Warehouse must be based on a subject-oriented data model which represents the business. Thus the data model for the Data Warehouse is required to be more comprehensive and generalized to reflect the many different aspects of an organization's business than the specific application.

- The Data Warehouse stores much more data than a typical data base - it must store both detailed data and history data in order to be able to answer unanticipated question. It may also store totals and summaries. Thus, the Data Warehouse has challenges associated with size.

In a nut shell, while transaction applications are coded with fixed logic, designed for repetitive input and optimized for performance, the Data Warehouse, on the other hand, is architected for flexibility and used by knowledge workers who may not know which questions they may ask next. This section discusses some of the important issues related to successful Data Warehousing, and suggests an implementation approach for the Data Warehouse project.

4.2 The Pilot Project

As the Data Warehouse project is quite different from a traditional application development project, a pilot Data Warehouse is recommended first. This Pilot will allow IT and users to gain experience, allow a change in culture to be formed, and provide the learning curve to the technical staff of working with very large data base.

4.3 Scope and Objective

To ensure positive results and increase the learning, the Pilot should have a focused objective and a specific scope. Typically a 2 to 4 month project is desirable as a first project.

4.4 The role of Executives, Users, IT and Experts

Strong executive sponsorship is essential. If the Data Warehouse is not supported as a corporate initiative, and not chartered to tackle high-value strategic business problems, it will not deliver the right level of results and may well whither.

Strong user participation and co-ownership is also very important. The knowledge workers hold the key to transforming data to information, and knowledge into competitive advantage.

Data Warehouse experts are also critical, as a number of customer projects have discovered. Different specialists are involved in a Data Warehouse project, including a senior architect, a data modeler, and technical experts for building, tuning and establishing the operations procedures for Very Large Databases. Also important is a business analysis conversant with data mining methodology. For example, customers can take advantage Oracle's specialized Data Warehouse Practice, part of the company's 5,000 strong consulting organization. Or use one of the many Systems Integrators and consulting houses in Oracle's Warehousing Technology Initiative partnership program.

4.5 Leveraging Data Model and Application Templates

Templates of data models and Data Warehouse applications developed for specific industries can provide a rapid transfer of Data Warehouse know-how effect rapid implementation.

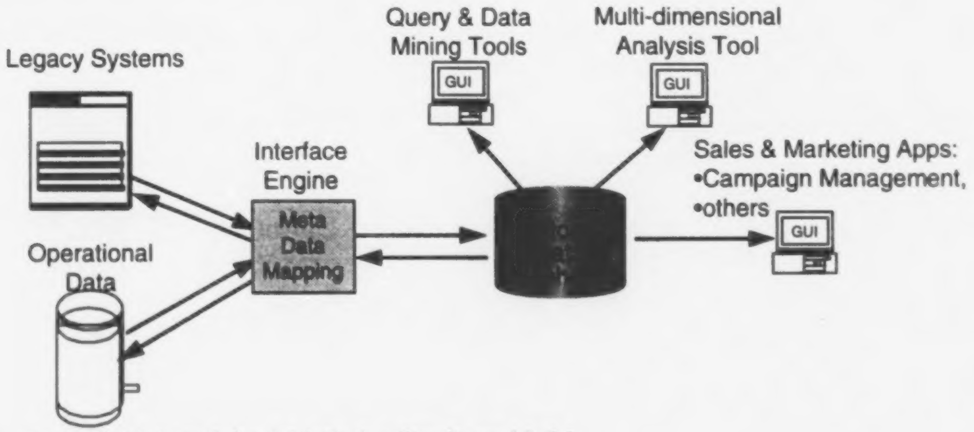


FIgure 2 - Oracle Quick Start Sales & Marketing Warehouse Model

For example, Oracle's Quick Start Warehouse offers prebuilt models and methodology which can be quickly customized to a customer project. Oracle Quick Start Warehouse includes:

1. A senior Data Warehouse architect who can quickly assist the customer layout a project plan and get buy-in from sponsoring executives.
2. Data models for the telecommunications business developed and refined with multiple service providers.
3. Prototype sales and marketing applications like Target Marketing and Campaign Management built using CASE tools and object technology which make them very easy to change.
4. A choice of data extraction, cleansing and matching utilities from best of breed software companies which have been integrated to work with Oracle's high speed database loading and data gateway products.
5. OLAP, query and report writing modules which have been integrated and tested with the total solution.
6. Project and training plan, data warehouse development and data mining methodology with Oracle Consulting services which can be effectively transferred to the customer users and IT staff.

5. SUMMARY AND DATA WAREHOUSE'S PLACE THE FUTURE

To be success in implementing a Data Warehouse, the critical success factors include:

- Business driven objective and executive sponsorship
- Robust Data Warehouse engine
  - High performance "parallel everything" technology
  - Proven ability to scale to very large databases (terabytes)
  - Extensive choice of analysis, query and development tools.
- Thorough data preparation, cleansing and business data definition.
- Consultant with proven experience in delivering Data Warehouse solutions

For any mass market facing industry, the winners will be those who have:

- Large Data Warehouse
- Direct access by decision makers and knowledge workers
- The ability to transform data into knowledge, knowledge into action

As surely as information will be the lifeline for the future enterprise, the Data Warehouse will certainly become a fundamental component of the information system architecture of the competitive organization.. What's more, the future Data Warehouse will contain many types of data - structured data, text, audio, video, and complex objects. And it will be used by all level of the enterprise, not just knowledge workers. Access to online external data feed will be prevalent.

Companies will start hooking up their Data Warehouses to form strategic links, reduce information latency, minimize inventory and cut out the middlemen. Already, this is happening in the merchandizing industry where powerhouses like Wal-Mart and K-mart have linked up their Data Warehouses with Proctor and Gambol and hundreds of other suppliers. They have fundamentally transformed their relationship and business model and redefined the value chain. In industry after industry, power is moving downstream toward the customer. Those telecommunications service provider who view their customer interface as having the most strategic potential and who regard their business as providing a conduit to a new world of online services has the opportunity to realize a new order of opportunities. In the competitive information age, the Data Warehouse will be a core requirement to this evolution.

Call Data System: Flexible and Integrated Operations, Management and Control of Telecommunications Networks

Yasuo Ichiya, Ichiro Kase, Kazuhiko Ogawa, Takashi Yoshida & Makoto Niimura
NTT Telecommunications Software Headquarters
Chiba, JAPAN

1. ABSTRACT

Increasingly fierce competition among telecommunications network operators requires them to build network infrastructures which will both provide telecommunications services in a timely manner and enable them to micromarket their services based on detailed network usage information. At the same time, telecommunications operators need to efficiently manage their network which integrates services such as POTS, ISDN, videotex, and VOD.

This paper proposes the concept of call data, and, based on this concept, proposes new system architecture where all the switches in the network generate and transfer call data to a Call Data System (CDS) where operations systems can collect and process the data as needed.

Call data makes available a wide range of applications required in the current competitive environment to telecommunications operators. One such application is the migration of the billing function, which traditionally has been an essential function of switches, to operations systems. Calculating tariffs from call data enables telecommunications operators to provide flexible tariff-related services in a timely manner by confining changes to the operations systems. The CDS also provides a unified interface to the integrated network from any operations systems. Operators can achieve comprehensive network management and control by sending necessary data, such as system files and control commands, to any switch.

NTT is now developing and installing the CDS in one of the largest networks in the world consisting of about five-thousand digital switches. Because of the large scale of the network, benefits from the CDS should be enormous.

2. INTRODUCTION

Telecommunications operators worldwide are facing fierce competition due to liberalization and globalization. Competition is forcing them to change in terms of service provisioning and network management:

- Operators need to reduce costs and time needed to market their telecommunications services. To provide most new services, they need to upgrade both the software of switches and that of operations systems which usually takes more than two years. Thus, it gives them a competitive advantage to confine software changes in their network for providing new services timely and economically.

- Operators have to allow their marketing staff free access to detailed usage information on specific customers or specific services to support effective marketing activities. Providing marketing staff with raw data to process as they see fit is more effective than providing them with data processed at switches for specific needs.

- As opposed to a relatively simple index, call loss, in POTS, operators need to manage the network which integrates services such as POTS, ISDN and VOD by multiple indices to maintain sufficient quality for each service. It is more flexible to generate such indices at operations systems based on the data obtained from switches than to generate them at switches.

- Operators need to manage the integrated network efficiently. Thus, they have to minimize manual operations at switches and attain comprehensive control functions over the network from remote operation centers.

This paper proposes the concept of call data and the Call Data System (CDS), which provides the network infrastructure necessary to foster the above changes. Under the new system architecture, all the switches in the network generate and transfer call data to the CDS, and operations systems collect and process them as they see fit. Operators can readily implement various operation functions without having to modify expensive switch software. This architecture also facilitates an autonomous and responsive management environment required to remain competitive because data processing functions are under the discretion of call data users.

3. CALL DATA SYSTEM

3.1 CALL DATA

Call data indicates the connection history of a call for any telecommunications service. Conventionally switches generate data for a specific operations system, whereas they generate call data to be shared by multiple operations systems. Furthermore, items to express call data are defined commonly among telecommunications services such as POTS, ISDN, videotex, and VOD. Thus, the call data of all services have basically the same format. Table 1 shows an example of the items forming call data.

Table 1 AN EXAMPLE OF CALL DATA ITEMS

- service category
- calling party number
- called party number
- dialed number
- calling party's category
- starting time
- ending time
- calling switch number
- connection route
- response type
- cause of incomplete calls

Call data are generated in the following way for effective use by operations systems:

- One set of call data is generated per call. If multiple call data are generated per call, operations systems need to combine the call data for each call, which is a duplicated function among operations systems. Call data are generated in the following way for effective use by operations systems.

- A calling local switch generates call data because it has the most information concerning a connection of a call. Information unknown to a calling local switch is transferred from other switches, such as a Service Control Point (SCP) and a gateway switch, to it.

- Call data are formatted using the ASN.1 coding regulation. Under the ASN.1 coding regulation, call data are expressed as a structured set of identifier, length, and value (Figure 1). Thus, adding or changing items in call data does not affect the formatting of other items, and operations systems can retrieve all the necessary values by the unified mechanism.

- Call data are generated not only for completed calls but also for incomplete calls because the call data for incomplete calls provide valuable information on the quality of the network.

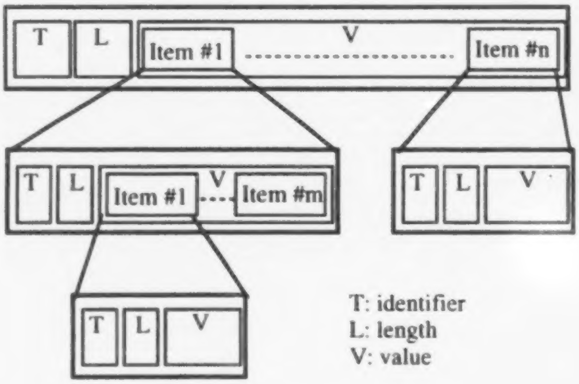


Figure 1 CALL DATA FORMAT USING ASN.1 CODING REGULATION

3.2 SYSTEM CONFIGURATION

The Call Data System (CDS) is a mediation network which effectively transfers call data generated in the integrated network to operations systems (Figure 2). For this purpose, the CDS needs three basic functions: collecting, grouping, and delivering.

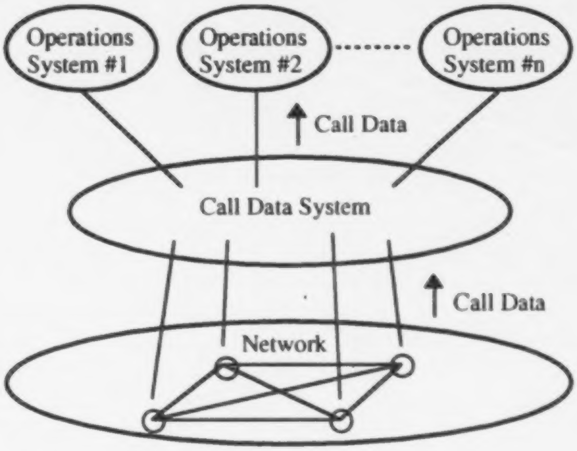


Figure 2 CALL DATA SYSTEM

- The collecting function collects call data from switches in the integrated network. Since there are various switches in the network, this function includes absorbing the differences in their interfaces.

- The grouping function classifies call data into several groups based on their attributes so that operations systems can collect only necessary data. It selects the most common rules of classifying call data, such as completed calls versus incomplete calls and charged calls versus non-charged calls, for operations systems (Table 2). The validity of call data also needs to be checked at the time of classifying call data.

Table 2 AN EXAMPLE OF CALL DATA GROUPING

Switch ID	Response Type	Charge Type	Call Data Group
calling switch number	incomplete calls		Group A
	complete calls	charged calls	Group B
		non-charged calls	Group C

- The delivering function saves call data for a specified period, typically for a few days, and delivers them based on requests from operations systems.

The CDS proposed in this paper consists of two nodes: switch adaptors and grouping nodes (Figure 3). The switch adaptors control the collecting function, while the grouping nodes control the grouping and delivering functions.

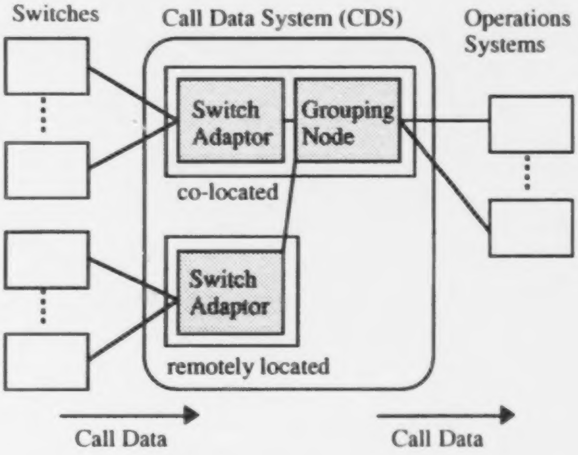


Figure 3 SYSTEM CONFIGURATION OF THE CDS

The collecting and delivering functions should be separated in the CDS for the two reasons when it is applied to a nationwide integrated network.

First, the number of switches in the network is too large to combine these two functions in one node. The number of nodes with delivering functions has to be from one to about fifty for the convenience of operations systems accessing the CDS. In case of a moderate-sized network with hundreds of switches, switches could be directly connected to grouping nodes. However, it is more realistic to separate these two functions into different nodes in implementing them for a network with a few thousand switches.

Secondly, switches have too diverse interfaces to accommodate in one node. Various types of switches, such as generic switches for POTS and video servers for VOD, are included in the integrated network, and they have proprietary interfaces to the CDS. Even the interface of telephone switches will differ according to the type of switch. Thus, it is easier to develop separate interface nodes for switches. Specifying a unified interface between the node with the collecting function and that with the delivering function makes it easy to add new types of switches connected to the CDS. Therefore, the collecting and delivering functions are separated into different nodes.

The grouping and delivering functions are allocated to grouping nodes because the grouping function is necessary for storing call data at grouping nodes. If the grouping function is allocated to switch adaptors and grouping nodes do not look at the items of call data in storing, then the switch adaptors need to send call data to the grouping nodes in classified groups, which would complicate the interface between the switch adaptors and the grouping nodes.

3.3 TRAFFIC DESIGN

The CDS must be designed so that call data are efficiently transferred to grouping nodes in a timely manner. For this reason, traffic design between switches and switch adaptors and that between switch adaptors and grouping nodes are considered in different ways (Figure 4). The following is the definition of design parameters:

SW_{ij} : maximum amount of call data sent from SW_{ij} in one second
SA_j : maximum amount of call data collected at SA_j in one second
n_j : number of switches under SA_j
SW'_{ij} : maximum amount of call data sent from SW_{ij} in the busiest hour
GN'_k : maximum amount of call data collected at GN_k in one hour
m_k : number of switches under SA_j

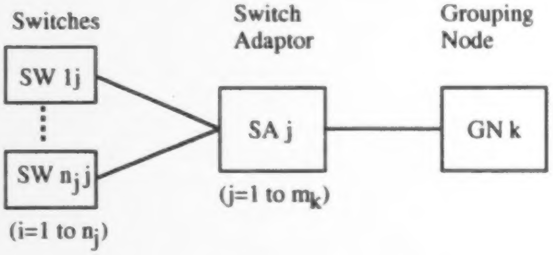


Figure 4 TRAFFIC DESIGN FOR THE CDS

Traffic between switches and switch adaptors is designed to prevent unsent call data from piling up in switches. Otherwise, call data could overflow the memory area of switches and end up lost. Therefore, a switch adaptor must have enough capacity to collect call data even when all the switches under it send their maximum amount of call data. Switches are connected to a switch adaptor under the condition that the sum of the maximum amount of call data sent from switches in one second is below the maximum amount of call data collected at a switch adaptor in one second. Thus, the condition below must be satisfied:

$$SA_j \geq \sum_{i=1}^{n_j} SW_{ij}$$

The interface between switch adaptors and grouping nodes should be designed in a longer time frame, typically in one hour, and a specified amount of call data should be allowed to pile up for efficient use of resources. It is too costly to send all call data in real-time even when all the switches under a grouping node send their maximum amount. Thus, a grouping node must have enough capacity to collect call data in the busiest hour, while a part of the peak traffic from switches is temporarily stored at switch adaptors. Thus, switch adaptors need to have enough memory to store call data from switches. When a time frame is taken as one hour, switch adaptors are connected to a grouping node under the condition that the sum of call data sent in the busiest hour from all the switches under it is below the maximum amount of call data collected at a grouping node in one hour. The following condition must be satisfied:

$$GN'_k \geq \sum_{j=1}^{m_k} SW'_{ij}$$

4. APPLICATIONS OF CALL DATA SYSTEM

4.1 APPLICATIONS OF CALL DATA

The applications of call data include billing, management of telecommunications services network, and supporting of marketing staff and the management (Figure 5). They retrieve necessary call data from the CDS and utilize call data items in the call data for their purposes. Operations systems to attain these objectives are under development at NTT.

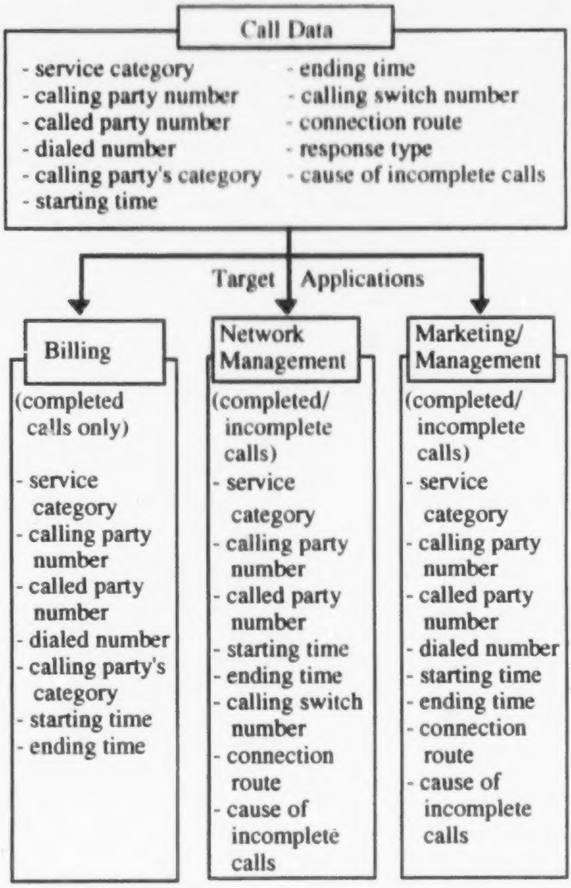

Call Data
- service category
- calling party number
- called party number
- dialed number
- calling party's category
- starting time
- ending time
- calling switch number
- connection route
- response type
- cause of incomplete calls
Target Applications
Billing
(completed calls only)
- service category
- calling party number
- called party number
- dialed number
- calling party's category
- starting time
- ending time
Network Management
(completed/ incomplete calls)
- service category
- calling party number
- called party number
- starting time
- ending time
- calling switch number
- connection route
- cause of incomplete calls
Marketing/ Management
(completed/ incomplete calls)
- service category
- calling party number
- called party number
- dialed number
- starting time
- ending time
- connection route
- cause of incomplete calls

Figure 5 TARGET APPLICATIONS OF CALL DATA AND CALL DATA ITEMS USED BY THEM

The primary application of call data is the migration of the billing function, which traditionally has been an essential function of switches, to a billing operations system. The billing operations system collects call data files of charged calls from the CDS and calculates the tariffs. Conventionally switches calculate call tariffs, and operations systems additionally process tariff data based on the contract information of customers. Thus, calculating tariffs from call data enables telecommunications operators to provide flexible tariff-related services in a timely manner without changing the software of switches. This will reduce the development cost of new services. Due to this migration, switches can devote their expensive processing power to their generic function of connecting calls. The billing operations systems also benefit because they get a unified format of data from the unified interface across telecommunications services.

Secondly, call data can be used for network management of any telecommunications service. Call data provides quality information by service or by route. Unsatisfactory results about blocking or waiting time of calls and usage rate of circuits indicate areas needing improvement in the network. Especially analysis of incomplete calls provides valuable information on bottlenecks in the network. Thus, call data immediately provide a basis for helping telecommunications operators accurately plan their networks.

Thirdly, call data can be used to monitor customer-specific, number-specific, and service-specific usage data for marketing activities and managerial decisions. Customer-specific traffic data from call data will greatly support micromarket telecommunications services, especially for large customers, and design their networks. Analysis of incomplete calls helps eliminate potential complaints from customers to maintain customer satisfaction. For managerial purposes, comprehensive usage data will be a basis for deciding tariffs or service conditions of new services and measuring customers' acceptance of these services.

4.2 NETWORK OPERATIONS AND MANAGEMENT THROUGH THE CDS

Another invaluable benefit from the CDS is that it provides a unified interface between the integrated network and operations systems. Through the CDS, operators can attain comprehensive network control by sending necessary data, such as system files and control commands, to any switch. A backup of duplicated links is used to send such data between switches and grouping nodes via switch adaptors.

The CDS enables operators to remotely load system files to any switch in the network and update system files in switches (Figure 6). Telecommunications operators need to install software files of their switches a few times a year to continuously upgrade its network capabilities. Consequently, much work and time are needed for the file installation, especially for operators of large-scale networks such as that of NTT. The long period of time needed to install system files could delay the marketing of new services. The CDS allows the transfer of office data files to an engineering operations system where a new system file for a specific switch is generated by coupling the office data file after the necessary engineering with a program file. Then, the engineering operations system sends the system file to the appropriate switch following the destination information labeled on the file. With the help of a operation tool to remotely update system files, operators can ultimately automate most time-consuming maintenance functions using the CDS.

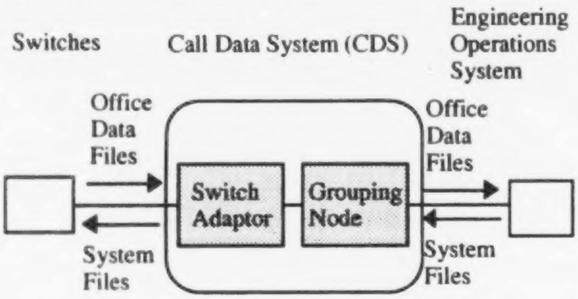


Figure 6 REMOTE LOADING OF SYSTEM FILES AT SWITCHES

Another application example is to send tariff tables for billing public phone calls inside switches and immediately rewrite the tables from a remote control center. Despite the migration of the billing function by introducing call data, some tariff tables remain in switches for charging real-time for public phone calls. They need to be updated every time the tariff for public phone calls changes. This operation also involves much work and time because they have to be updated at all local switches. Through the CDS, a tariff table operations system can send the tariff tables to all local switches in the network. Since the transmission of the tariff tables has to be extremely reliable, the CDS can double check the accuracy of the data (Figure 7). A switch adaptor sends back the received data to a grouping node and the grouping node compares them with the data it previously sent. When the grouping node finds that the data are the same, the switch adaptor sends the data to a switch. When it finds that they are different, it reports an alarm message to the tariff table operations system after a retry. The same send-back and check routine is repeated between switches and switch adaptors. The tariff table operations system can remotely monitor the results of sending the tariff tables and their updating at the switches. Thus, this operation function can greatly reduce time and work.

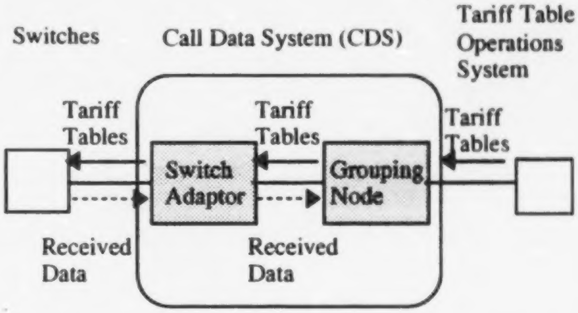


Figure 7 TRANSMISSION OF TARIFF TABLES TO SWITCHES

The third application is to collect memory dump data of switches in case of system errors. Switches leave memory dump data in reserved memory areas in case of system errors for analyzing the reasons for errors afterwards. The CDS provides the means to send memory dump data to a remote operations center.

5. CONCLUSION

Competition among telecommunications operators is forcing them to change in terms of service provisioning and network management. This paper has proposed a new network infrastructure which accommodates these changes through the use of call data, a form of data generated at switches in the integrated network and shared among operations systems. The Call Data System here enables the network to efficiently deliver the call data to operations systems. Call data has a wide range of applications. It can help provide new tariff-related services in a timely and economical manner, manage the quality of network services, and market services to customers. Operators can also reduce the time and work for installing files and modifying tariff table in switches using the Call Data System as a unified interface to the integrated network.

Creating Customer Loyalty Through Front-Line Sales/Service Contacts

Berth Jönsson, Bruce Carruthers, Sara Bier
SMG North America
San Francisco, United States

ABSTRACT

This paper presents a proven, common-sense approach to increasing and sustaining employee effectiveness, customer loyalty, corporate growth, and profitability for telecommunications carriers. The methodology—Managing Value Potential (MVP)—focuses on the interface with customers as the key to the creation of value and competitive advantage. This paper discusses the rationale behind the MVP approach, outlines the steps of the approach, and demonstrates its effectiveness for communications companies.

INTRODUCTION

The telecommunications marketplace is one of the most competitive in the world. Once-protected markets are opening up; technological advances are rendering regulatory rules obsolete or irrelevant; government monopolies are privatizing, challengers are crossing national boundaries; companies are diversifying their offerings and expanding their reach through various strategic partnerships. The result is that consumers and businesses alike are coming to expect more and more choice in providers and service offerings. In the most competitive markets, where the battle for customers is fiercest, customers find it easy to switch from carrier to carrier, and the newer carriers in particular use all manner of incentives to encourage them to do so: special price promotions, free talk time, airline mileage, and even cash. While some carriers may realize short-term gains when they play the switch game, they all eventually pay the price in customer turnover, or churn. For example, in the U.S. long-distance market, it is estimated that every day 60,000 customers switch long-distance providers. In the U.S. cellular market, churn rates are estimated at between 2 and 3 percent per month, or as much as 36 percent a year. Considering the cost of attracting a new customer to replace each defector (variously estimated between $300-$700 for U.S. cellular carriers) and the amount of lost revenue each lost customer represents, churn is a costly by-product of lower customer switch costs. And as competition intensifies, churn problems will only worsen.

To sustain competitive advantage and ensure profitability in such an environment, companies must concentrate on building a loyal customer base. By focusing on consistently high levels of value and service, providers can create very satisfied customers who, studies show, are most likely to *remain* customers. Loyal, long-time customers create value for a company: for every satisfied, long-time customer, a company recoups its original acquisition costs, earns higher levels of revenue, reduces handling costs, lowers its marketing expense, and creates a positive image. As technological advances tend to equalize the technical quality of carrier offerings, customer satisfaction and, therefore, loyalty will increasingly be driven by the front line sales and service interactions between the customer and carrier. Carriers that achieve a loyal following will be those that best manage the personal interactions with their customers.

SMG's Managing Value Potential (MVP) methodology is designed to enhance the effectiveness of the employees having the greatest impact on customer satisfaction and loyalty—the front-line sales and service personnel.

The MVP METHODOLOGY

The MVP methodology is based on three tenets:

- Loyal customers have the most profit potential, other things being equal.
- Very satisfied customers are more likely to be loyal than merely satisfied customers.
- High satisfaction and dissatisfaction are created pri-

marily by the sales and service experiences customers have with front-line employees.

TENET 1: LOYAL CUSTOMERS HAVE THE MOST PROFIT POTENTIAL

Generally speaking, customer loyalty increases profits by lowering customer churn, sustaining growth, and raising price premiums. That is not to say all loyal customers are necessarily profitable. Because of pricing peculiarities and regulations, some customer segments may be loyal for the wrong reason: the subsidies they receive. But for customer relationships that are at least marginally profitable to begin with, loyalty will increase a company's payoffs over time. Loyal customers are more willing to pay for the benefits they receive and are more tolerant of price increases. AT&T is a prime example of a company that continues to command a higher price of its long-time, loyal customers. In addition, loyal customers are likely to buy more frequently and in greater volume and to purchase other products and services offered by the same firm. Companies with loyal customers commit fewer resources to handling returns and managing complaints; thus, they lower operating costs. Loyal customers are more likely to engage in positive word-of-mouth advertising and less likely to engage in negative word of mouth, enhancing the overall reputation of the firm.

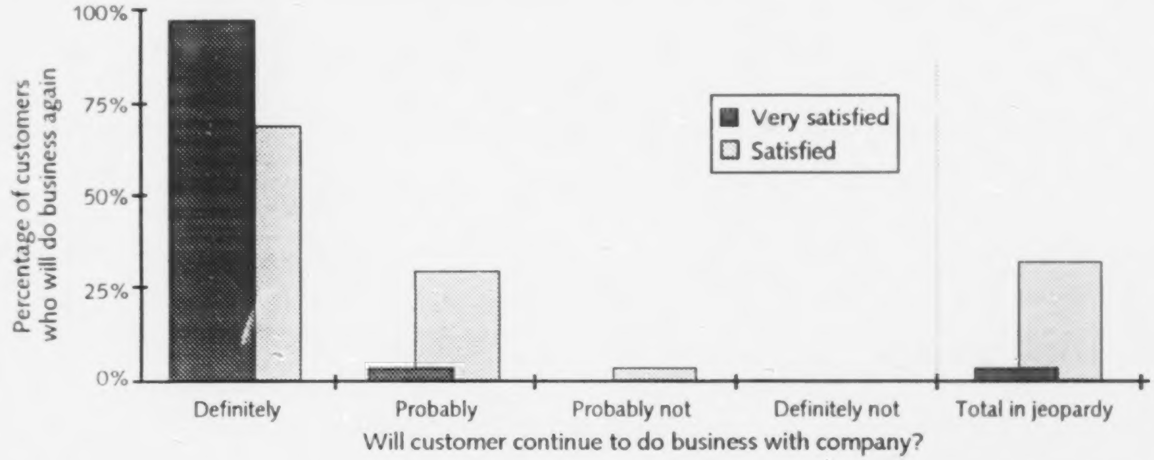
TENET 2. VERY SATISFIED CUSTOMERS ARE MORE LOYAL THAN MERELY SATISFIED CUSTOMERS

Merely satisfied customers will stick with a company until something better comes along. They are susceptible to offers of discount pricing and promotional packaging offered by competitors. However, very satisfied customers are much more difficult to lure away. Research by Steffen, Steffen & Associates has found that a customer who is merely satisfied with a service experience is a potential defector; loyal customers are those who are very satisfied or delighted. In fact, data from a study of a large telecommunications company show that a merely satisfied customer is as much as 10 times more likely to defect than a very satisfied customer (see Figure 1).

TENET 3: CREATING VERY SATISFIED CUSTOMERS BEGINS WITH THE FRONT-LINE EMPLOYEE

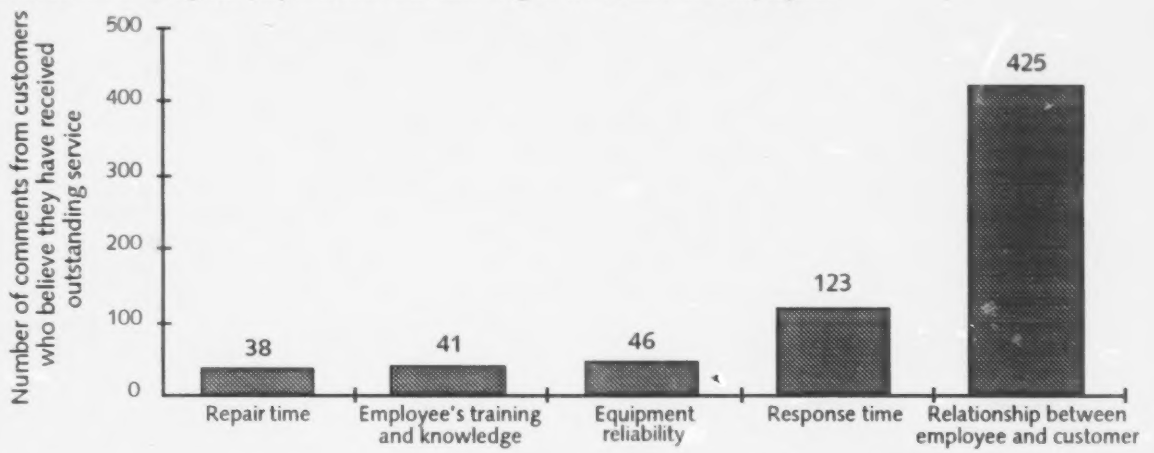
As with many retail services, customer perceptions of telecommunications service quality are formed primarily during customer interactions with front-line service representatives (sales representatives, installers, repairers, phone service representatives). As suggested in Figure 2 (next page), customers who believe they have received outstanding service comment on the employee/customer relationship almost twice as much as the total of the next four items.

FIGURE 1. Very satisfied customers are loyal



Source: Steffen, Steffen & Associates

FIGURE 2. Creating the very satisfied customer begins with front-line employees



Source: Study of major U.S. long-distance carrier, Steffen, Steffen & Associates

As further evidence, the following statistics were identified in a study among Fortune 150 customers by Dr. Jagdish Sheth, University of Southern California:

- A dissatisfied employee is 20 percent less productive than a satisfied one.
- For every 1 percent of employees who are dissatisfied, 5 percent of customers will be dissatisfied.
- Customers can identify with 79 percent accuracy which employees are poor performers.
- Customers can identify with 92 percent accuracy which employees are dissatisfied.

Given the importance of front-line employees to the loyalty-creation process, the question then becomes "how can companies measure and manage the effectiveness of those employees in creating highly satisfied customers?" The MVP methodology provides a framework for accomplishing both goals.

IMPLEMENTING THE MVP APPROACH

The MVP approach involves four steps:

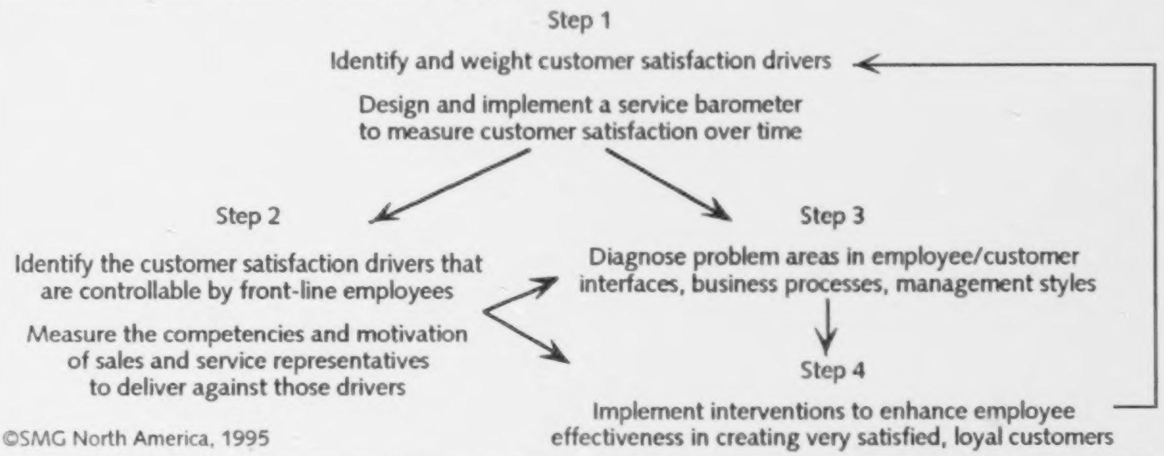
- Identifying and weighting customer satisfaction drivers; designing and implementing a service barometer to measure customer satisfaction over time
- Identifying the customer satisfaction drivers that are controllable by front-line employees; measuring the competencies and motivation of sales and service representatives to deliver against those drivers
- Diagnosing problem areas: identifying weaknesses in the employee/customer interfaces, business processes, management styles
- Implementing interventions to enhance employee effectiveness in creating very satisfied, loyal customers.

The relationship between the four steps of this approach is represented in Figure 3 on the next page. The process is an interactive one. Through periodic customer-satisfaction surveys and internal employee surveys, problem diagnosis, and focused interventions, the process enables a company to respond to competitive pressures and evolving customer expectations.

STEP 1: MEASURING CUSTOMER VALUE ADDED (CVA)

The objective of Step 1 is to create a reliable attribute tree that weights the drivers of customer satisfaction from the initial sales contact through the continuing service relationship (maintenance, repair, billing inquiries, problem diagnosis, etc.). As an example of what is meant by a weighted attribute tree, Figure 4 (next page) shows the relative weights of several hypothetical service factors that contribute to an overall perception of service quality.

FIGURE 3. Steps in implementing the MVP approach


Step 1
Identify and weight customer satisfaction drivers
Design and implement a service barometer to measure customer satisfaction over time
Step 2
Identify the customer satisfaction drivers that are controllable by front-line employees
Measure the competencies and motivation of sales and service representatives to deliver against those drivers
Step 3
Diagnose problem areas in employee/customer interfaces, business processes, management styles
Step 4
Implement interventions to enhance employee effectiveness in creating very satisfied, loyal customers

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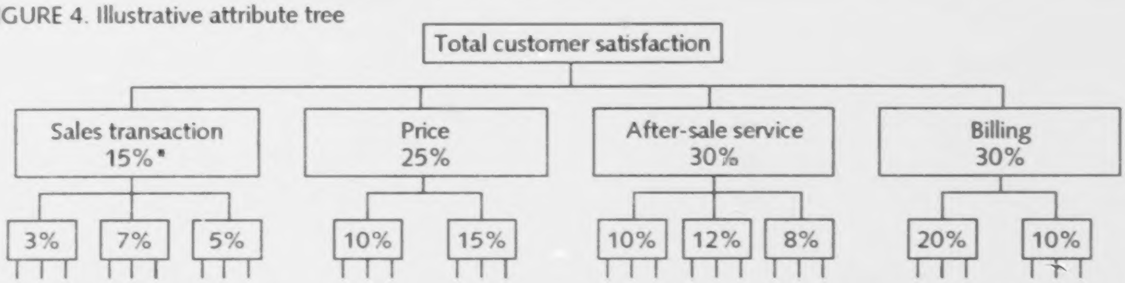
This step is crucial to the overall MVP approach because the remaining steps are premised on having reliably weighted measures of customer purchase and loyalty drivers (that is, CVA). Knowing the relative importance of the drivers for customers allows a company to focus its energy and resources on improving the things that customers care about most.

Generally, this step requires either analysis of a company's existing customer satisfaction data, or, if no current data exist, design and administration of customer surveys (not only for existing customers, but, as important, for lost customers and competitors' customers, who represent growth opportunities). Additional information from field studies and focus groups is also gathered for input to the survey design to determine, among other things, how expectations differ among various market segments and to what extent customer satisfaction drivers differ by distribution channel.

The customer survey instrument should be administered frequently enough to capture changes in customer attitudes and behavior before they undermine the company's market position. The survey instrument itself may have to evolve as market expectations change. We call this overall process "the customer service barometer." Properly designed, a service barometer should reflect differences in expectations among targeted market segments and among users of different distribution channels. Further, it should contrast satisfaction levels of customers with customer satisfaction levels of competitor(s)' customers, particularly with respect to the key factors driving customer purchase decisions and loyalty. To facilitate the tracking, analysis, and reporting of barometer results, historical databases, a reporting program, and report templates are also developed during this first step. Beyond helping companies stay current on market demands, the barometer enables a company to measure performance improvements, correlate results with changes in market share

FIGURE 4. Illustrative attribute tree


Total customer satisfaction
Sales transaction 15%*
Price 25%
After-sale service 30%
Billing 30%
3%
7%
5%
10%
15%
10%
12%
8%
20%
10%

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*Percentage of contribution to total satisfaction and other hard financial numbers, analyze results for internal and external benchmarking, and track performance relative to competitors on a continuing basis.

STEP 2. MEASURING PEOPLE VALUE ADDED (PVA)

As they interact with customers, individual service representatives have varying degrees of control over the levers that create customer satisfaction. Thus, to achieve the greatest payoff in actionable results, in this step we survey employee competencies and motivation with respect to those factors over which employees have direct control. To isolate those drivers, it is necessary to look at job descriptions and associated business processes as well as interview service employees and their supervisors. Having isolated those drivers, the next step is identifying the key employee-effectiveness issues tied to those drivers. Such issues cover:

Awareness. Employees must be made aware of the customer satisfaction drivers and their role in creating satisfaction. Frequently companies collect information about customer satisfaction drivers, but do not successfully communicate the information to their front lines. Customer survey data reveal that employees often need additional training in specific areas such as handling specific customer problems or knowing how the company's products compare with competitors'.

Tools and systems. Front-line employees must be able to access quickly information for and about their customers and the company's products, services, and policies; to do so, they need the proper tools and systems.

Authority. Customer-facing employees must be granted an appropriate amount of authority to make decisions that affect customer satisfaction. What latitude do employees have to correct a customer's problem? What options can they present the customer?

Motivation. Employees should be made responsible for the customer satisfaction drivers they control in their job and receive rapid, clear feedback through recognition programs, job reviews, and financial incentives.

Employee survey questions can be developed around these issues, as illustrated in Figure 5.

FIGURE 5. Survey questions related to employee-effectiveness issues (satisfaction driver: perceived price)

Employee-effectiveness issue		*Related survey questions*
Awareness	Do salespeople attach the same weight to price as customers do?	The customers I deal with are primarily motivated by price when they make their purchase decisions. Financing terms are more important in making a sale to potential customers than the actual price of the offering.
	How do company's prices compare with competitors'?	In general, for equivalent services, our prices are *equal to, above, or below* our competitors' prices. We know on a day-to-day basis how our service prices stack up against competitors' offerings.
Tools and support	Do information systems facilitate the most cost-effective arrangements for satisfying customers' needs?	Our information system allows us to profile a particular customer's needs accurately and quickly. I have the tools to configure the most cost-effective service arrangement for a customer.
Authority	Are salespeople given sufficient flexibility in setting contract terms?	I often lose prospects because I am not allowed enough flexibility to tailor price and terms to their needs. I have little influence on long-term customer loyalty.
Motivation	Is the reward system consistent with the customer price weighting?	Our incentive plan encourages me to save customers money. Whenever possible, we in our unit try to sell customers more than they need.

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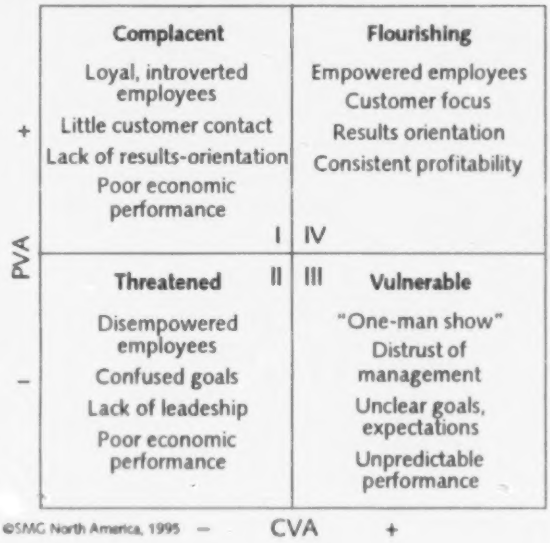
To provide sharp diagnostic capability, the employee effectiveness (PVA) survey must be tailored to the various customer-facing work operations. Certain issues can be addressed by a generic set of questions, but other key issues may be peculiar to selected job functions. The employee surveys need not, for these purposes, be administered as a census. Relatively small samples can yield powerful insights.

STEPS 3 & 4. DIAGNOSING PROBLEM AREAS AND IMPLEMENTING INTERVENTIONS

FIGURE 6. Organizational diagnoses



Complacent Loyal, introverted employees Little customer contact Lack of results-orientation Poor economic performance	**Flourishing** Empowered employees Customer focus Results orientation Consistent profitability
Threatened Disempowered employees Confused goals Lack of leadership Poor economic performance	**Vulnerable** "One-man show" Distrust of management Unclear goals, expectations Unpredictable performance

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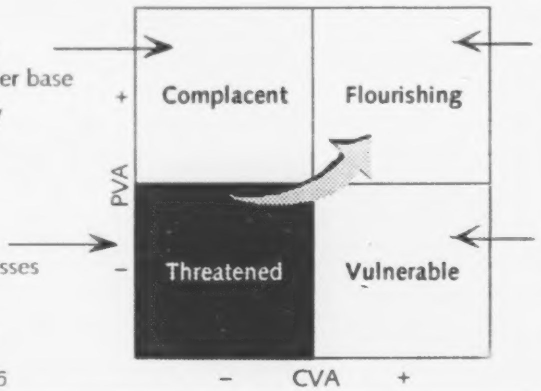
Figure 6 illustrates in broad terms the diagnostic value of properly designed measures of employee effectiveness (PVA) and customer satisfaction (CVA). By plotting CVA and PVA levels for a company's business units on a matrix such as the one shown in Figure 6, we can determine the strengths and weaknesses each possesses with respect to creating effective employees, satisfied customers, and shareholder value. For example, in the "Threatened" quadrant, employees are typically unmotivated and disempowered; customer focus is lacking; and business units are unprofitable as a result. In the "Complacent" quadrant, employees are loyal, but unprepared to meet customer needs; customer defections are common and, again, economic performance is poor. In the "Vulnerable" quadrant, an often dogmatic leader sets customer goals, but employees are neither motivated nor loyal, so economic performance is unpredictable. In the "Flourishing" quadrant, business units are responsive to the market and, therefore, consistently profitable because employees are aware of the factors that drive customer satisfaction and are prepared to deliver against them.

Figure 7 suggests possible responses to each diagnosis. Given a tight linkage between PVA and CVA, it is possible to calculate in advance the payoffs of specific organizational interventions on customer satisfaction and, ultimately, on market share. Ideally, the diagnosis and remedies should be made at the lowest operating level to achieve the greatest payoffs.

Interventions vary depending on the situation each business unit or group of business units faces. In units where both PVA and CVA are low, far-reaching inter-

FIGURE 7. Organizational interventions



Develop customer focus:
- develop ties to customer base
- focus on accountability

Reengineer:
- revamp business processes
- replace leadership
- focus on core training

Secure firm's position:
- continuously update intelligence
- enable continuous improvement
- transfer competencies to other units

Empower employees:
- encourage team building
- develop employee confidence
- insure continuity in tools and systems

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ventions—reengineering business processes or restructuring the organization—may be called for. In units where CVA is low and PVA is high, training to build employee awareness of customer satisfaction drivers and modifications in management style may be needed. For units having high CVA and low PVA, changing management style and practices is often required as well as upgrading support systems and starting programs to improve employee competencies. The business practices found in units having both high PVA and high CVA are used as models for other units to emulate. Interventions for units in the "Flourishing" quadrant usually focus on sustaining a competitive edge.

When companies put in place reliable measures of CVA and PVA, we find strong correlation between customer satisfaction levels, on the one hand, and the degree to which employees are aware of customer needs and believe they can serve those needs, on the other. For example, Figure 8 maps the customer satisfaction index for a large retail banking institution against a PVA index that reflects employee awareness of customer drivers and their perceptions about tools, competencies, authority, and incentives to deliver satisfaction. The dots represent a sampling of the bank's branches. The challenge for the bank was to move the poorly performing branches in the northeasterly direction to emulate the high performers. The PVA survey instrument and the associated results were specific enough to tailor interventions to each branch, helping them improve customer satisfaction performance and ultimately market share and revenues. Moreover, this framework provided a statistical basis for estimating the CVA and revenue payoffs from the various interventions considered.

FIGURE 8: Correlation between PVA and customer satisfaction

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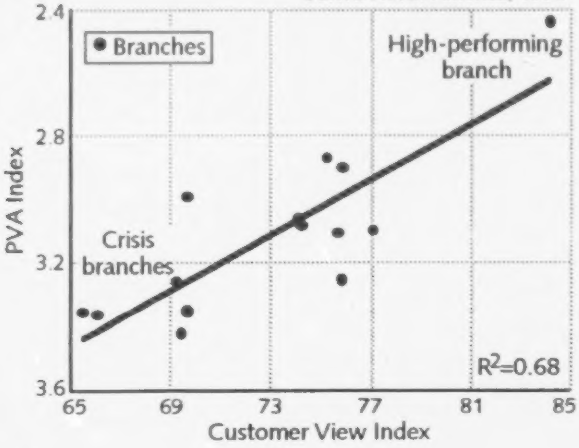

SUMMARY

As competition expands in the telecommunications marketplace, customer loyalty will be a principal determinant of success.

Loyalty is formed by making customers highly satisfied, not merely satisfied.

Increasingly, satisfaction is determined by the interactions between the customer and front-line personnel.

In order for those personnel to be effective in creating satisfaction, they have to know what customers want, in what priority, and they need to have the tools, training, authority, and motivation to deliver it.

Properly designed surveys and other market feedback systems can measure and weight those service attributes that drive customer satisfaction.

Working with that external market information, employee surveys can be developed to measure the effectiveness of employees in delivering highly satisfied customers (by focusing specifically on their awareness of the customer drivers they can control and their tools, authority, and motivation to deliver against those drivers).

By integrating both the customer satisfaction (CVA) and employee effectiveness (PVA) measures within a single system (such as MVP), companies can create a powerful tool to reinforce customer loyalty by focusing on organizational interventions that promise the highest customer satisfaction payoffs. Properly designed, such a system facilitates organizational learning through efficient transfer of knowledge.

Using the mapping techniques described, the best performing organizational units can be emulated, and the poorer performers can be improved through targeted interventions, for which the payoffs can be known in advance.

Pacific Telecommunications Council
2454 South Beretania Street, Suite 302
Honolulu, Hawaii 96826 USA
Telephone: 1.808.941.3789 Facsimile: 1.808. 944.4874
E-Mail: info@ptc.org

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Foreword

The Pacific Telecommunications Council's eighteenth annual conference, PTC'96, is now a two-volume reality.

Over the past years, PTC has organized a rich social-informational environment which has greatly facilitated knowledge building and networking of academic, business and governmental participants. This year's foci are manifest in seven streams: Socio-economic issues; regulatory, legal and political issues; business and finance solutions; country studies; education, training and human resources; convergence and networks; and, technologies and standards.

The quality of the papers in this volume, in the editors' assessments, has never been equalled. The"blind" review process (no names are associated with any submission) started with more than 330 proposed papers and resulted in the selection of 130. Each has been assigned to an appropriate session in a manner that will hopefully minimize conflicts for participants in covering their selected topics.

PTC'96, *The Information Infrastructure: Users, Resources and Strategies,* is organized in two volumes. **Volume One of the proceedings contains the papers presented on Monday of the conference. Volume Two contains the Tuesday and Wednesday papers.** As in the past, each volume has an index of subjects and a country/regional index. Once you have identified the paper you want to access, go to the table of contents, locate the paper, and refer to the page number. While it is appreciated that this two-step process is cumbersome, it is necessary in order to meet the tight "turn around" time between receiving the submissions and having the printed proceedings available at the conference.

For the past eighteen years the Pacific Telecommunication Council has organized a conference which has attracted many of the leading telecommunication professionals in the world. In order to do one's "homework" in this rapidly growing and changing environment, attending the annual PTC conference is now seen as essential. Events of such quality have at least a one-and-one-half year planning process. Successful conferences most definitely require dedicated volunteer work and first-rate PTC administrative and staff support in order to facilitate distinguished participants' contributions. The past conference successes speak well for a high quality and dedicated group of people. Finally, the support for the printing of the PTC'96 conference proceedings comes from AT&T Submarine Systems, Inc. Their contribution is most appreciated.

Now, on behalf of the PTC conference committee we want to extend a warm welcome to you. From the quality of the conference program and the quality of the papers in these volumes, PTC'96 promises to expand the reputation of a first-rate conference.

Aloha,

Dan J. Wedemeyer
Richard Nickelson
Honolulu, 1996

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TABLE OF CONTENTS

Subject Index
Country and Region Index

Monday, 15 January 1996

1 M.1.1.1 CATV-Telephony Convergence in Asia
Alexandra Rehak, Achmad Chadran

8 M.1.1.2 Converging Technologies: Towards Enterprise Integration
Dušan P. Jokanovic, Norio Shiratori, Kyosuke Moizumi

16 M.1.1.3 The Development of Interactive Multimedia Services (IMS)
Samantha Hon

21 M.1.1.4 MMDS: A Low-Cost Infrastructure for Video, Voice, and Data
Bruce Carruthers, Stephen Czarnecki, George Mandanis

26 M.1.2.1 Pacific Islands Business Network (PIBN): Marketing Oceania Overseas
James Di Giambattista

30 M.1.2.2 Libraries on the Information Superhighway: the Australian Experience
Carole A. Alcock

39 M.1.2.3 Multimedia and Asynchronous Learning: The Delivery of Education and Training Utilizing the Digital Library
Arthur S. Gloster II

46 M.1.3.1 The Impact of Wireless Local Loop Technologies in Asian-Pacific Markets
Andrew C. Simpson

54 M.1.3.2 Update on Mobile Satellite Services
Rex Hollis

59 M.1.3.3 Wireless in Indian Railway Telecommunication Network
Mohan Kishen Kaul, D. Swaminathan, B.A. Majmudar

62 M.1.3.4 Wireless Infrastructure in Vietnam: evaluating an emergent leapfrog strategy
A Lee Gilbert

71 M.1.4.1 The Impact of Local Competition on Universal Service Policies
Robert K. Yates, Johanne Lemay

78 M.1.4.2 Telecommunications in Transition: A Canadian Perspective on Ownership and Other Key Issues
Meriel V. M. Bradford

84 M.1.4.3 Intelsat Restructuring: How Can the Public Interest be Served?
Gregg Daffner

94 M.1.4.4 The Privatization of Intelsat: A User Perspective
Timothy S. Shea

100 M.1.5.1 Personal Communications Satellite Systems
Len J. Speltz

105 M.1.5.2 Advanced Modulation Techniques for Digital Satellite Modems
Henry Stewart, Rick Cannon

109 M.1.5.3 Transponder demand and supply in the Asia-Pacific region: How will they match over 1995-2005?
Stéphane Chenard

120 M.1.5.4 Roles of Satellite Communication in Global Information Infrastructure (GII)
Seon J. Chung

128 M.1.6.1 Enhancing Mexico's Information Infrastructure
Kathleen Ann Griffith

131 M.1.6.2 Palau Lightnet 2000 - A Telecommunications Revolution in an Emerging Nation
John J. Mariano, Karl E. Rye

139 M.1.6.3 The Information Infrastructure Meeting the Need of Bangladesh
Fazlur Rahman

144 M.1.6.4 Evolution of Information Networks and Future Trends in India
R.N. Bharadwaj, N.K. Srivatsava

152 M.1.7.1 Voice Mail Service in Advanced Intelligent Network
Kwang-Jae Jeong, Tae-Il Kim, Go-Bong Choi

159 M.1.7.2 Intelligent SS7 Network Management with S7DM
Jingsha He, Yi-Shang Shen, Don Albright

167 M.1.7.3 A Study on the DFP Architecture for Terminal Mobility: Design of the Terminal Access State Model
Ki Ryeung Kim, Tae Il Kim, Go Bong Choi

172 M.1.7.4 Open Programmable Switching: An Enabling Technology for Enhanced Services Deployment
Michael G. Hluchyj

177 M.2.1.2 Introducing Teledome Service - Making Effective Use of the Network Infrastructure in the Age of Multimedia
Naoki Takeda, Ryoji Tsukamoto, Tatsuya Ohtsubo

183 M.2.1.3 The Future Infrastructure for Commerce and Social Interaction - Ending the Tyranny of Distance, Place and Organisation
Robert G James

188 M.2.1.4 Efficient Broadcast File Transfer in a Satellite Communications Network
Gernot M. Engel, Dwight R. Bean

194 M.2.2.1 International Network Planning In a Changing Environment
Glenn L. Hunger, Arunabha Chatterjee

206 M.2.2.3 Strategic Network Challenges: The Case of Public Network Planning and Practice in Thailand
Robyn A. Lindley, Liaquat Hossain

213 M.2.2.4 End-to-End Multimedia Service Management Enabling Collaboration in a Distributed Enterprise Environment
Miyuki Sato, Kiyoh Nakamura, Sharad Kumar, David Liu, Rao Mikkilineni

220 M.2.3.1 A New Approach to Procurement Practices for the Undersea Cable Industry
Y. Niiro, S.W. Dawson, J. Roberts

225 M.2.3.2 FSA-10G Large Capacity Submarine Optical Amplifier System and Upgrade Trials for the Future
Masaki Amemiya, Yoshiaki Sato

233 M.2.3.3 Fiberoptic Link Around the Globe (FLAG) The FLAG Cable System Network
Robert E. Sullivan

238 M.2.3.4 Future submarine networks: the benefit of new technologies
P. M. Gabla

246 M.2.4.1 The Domestication of the Western Pacific
Veronica M. Ahern

252 M.2.4.2 The Introduction of Direct-to-Home Satellite Services into Canada: When Policy, Regulatory and Business Strategies Collide
Anthony H.A. Keenleyside

262 M.2.4.4 The Informatization of Japan: Creating an Information-Society or Just Good Salesmanship?
Jonathan M. Jaffe

274 M.2.5.2. Advanced Networks = Information, Education, Economic Development, Social Development
David R. Block

280 M.2.5.3 Critical Obstacles to Telecommunications Development in Developing Countries
Ryota Ono

290 M.2.6.1 The Building Blocks for Competitive Information Infrastructure
Andrew D. Lipman

298 M.2.6.2 Privatization: A Strategic Management Perspective
Diane Landau

308 M.2.6.3 Reforms in the Indian Telecom Sector
T.H. Chowdary

313 M.2.6.4 How Competition Will Change Management Strategies of Telecommunications Operators
Philip Parker, Michael Kelly, Stephen Hains

319 M.2.7.1 Toward a Global Network: The Evolution of Wide Area Networking in Rohm and Hass Company's Asia-Pacific Region
Lawrence H. Ostroff

327 M.2.7.2 Telecom Alliances for Emerging Economies: Breaking the Cycle of Under-Development Through Strategic Learning Alliances
Joan Kelly, Linda Booth

333 M.2.7.3 Making Information Technology Advances Work for You: BPR and Communication
Rein P Mere

342 M.2.7.4 Satellite Solutions for the Oil & Gas Industry
Rajiv Kumaraswamy

347 M.3.1.1 Mobile Satellite Services: Pie in the Sky or a Practical Solution to the Telecom Needs of the Pacific?
Donald B. Falle

354 M.3.1.2 Status of PCS in the United States
John Swart

358 M.3.1.3 PHS: A New Advanced Infrastructure for Mobile Communications and Wireless Local Loop Applications
Hideo Okinaka

366 M.3.1.4 Regulatory Aspects of an International PCS Satellite System
Edward R. Slack

372 M.3.2.1 Advanced Technology in DAMA Networking
Mark Dankberg

378 M.3.2.2 Smart-Networking-Efficient Technology Transparent Connectivity
John Puetz, Steve Hart

386 M.3.2.3 Reconceptualizing Telecommunication Delivery Systems for Rural Populations
Richard Dowling

395 M.3.3.1 Call/Connection Control in ATM Switching System for Multimedia Service
Seung-Hee Kim, Moon-Kyun Oh, Mi-Sook Han, Han-Kyoung Kim

401 M.3.3.2 Demand Forecast and Technologies Development on ATM Switching Systems in Korea
Byungryong Kang, Sungyeol Kang, Chimoon Han, Chuhwan Yim

409 M.3.3.3 A Control Scenario for Distribution Services in ATM Network
Moon-Kyun Oh, Seung-Hee Kim, Jong-Tai Lee, Han-Kyoung Kim

416 M.3.3.4 A Study on the Service Node System for Future Telecommunication Services
Sun-Moo Kang, Bu-Ihl Kim, Young-So Cho, Byung-Nam Yoon

423 M.3.4.1 Rules for an Interactive Road
Michael Reede

431 M.3.4.2 Electronic Commerce: Technology Overrules Law; The $50 Billion Pie
George E. Darby

435 M.3.4.3 The Legal Protection of Information Technology in Korea
Kyung-Han Sohn

447 M.3.4.4 Scambling Digital Images for Distribution Through Networks
Hiroshi Fujii, Noburou Taniguchi, Yasushi Yamanaka

453 M.3.5.1 Preparation for New Information Society: From Regional Cooperation to Domestic Development in the Asia-Pacific Region
Whajoon Cho, Byoung-Woo Lee

459 M.3.5.2 Politico-Economic Analysis of the Japanese Information Infrastructure Initiatives
Michael Latzer

467 M.3.5.3 A Strategic Plan for Building an Information Infrastructure: A Case for the U.S. Department of Treasury
Thomas J. McKeown, Ken Malley

476 M.3.5.4 National Information Infrastructure Policy in an Era of Global Networks
Johannes M. Bauer

484 M.3.6.1 Growth and Opportunity: Telecommunications Services Markets in APEC Countries
John W. Houghton

495 M.3.6.2 Hong Kong After 1997: The Effect on Telecommunications Services
Alan B. Kamman

505 M.3.6.3 Recent Developments Related to New Telecom Services, Private Sector Participation and Regulatory Policies in Sri Lanka
ADVN Kularatna, Gamini Gunawardana, P M Wickremasinghe, Lakmini Wijesundera

513 M.3.7.1 The Information Infrastructure: The Key to Precision Marketing for a Competitive Telecommunications Industry
Sandra B. Cook

519 M.3.7.2 The Strategic Importance of Data Warehousing in a De-regulated Telecommunications Market
Denis Tossan, Leigh Baker, Keith Budge

527 M.3.7.3 Call Data System: Flexible and Integrated Operations, Management and Control of Telecommunications Network
Yasuo Ichiya, Ichiro Kase, Kazuhiko Ogawa, Takashi Yoshida and Makoto Niimura

533 M.3.7.4 Creating Customer Loyalty Through Front-Line Sales/Service Contacts
Berth Jönsson, Bruce Carruthers, Sara Bier

Tuesday, 16 January 1996

541 T.1.1.1 Doing Business on the Internet: An Examination of Opportunities and Barriers to International Trade and Communications
Paula V. Brillson

547 T.1.1.2 Wrapped up in the Net: The Internet comes to Asia
Jeanette K. Chan

555 T.1.1.3 The Internet & Cyberspace Revolution: Implications for Developing and Developed Countries
Michael Potter

560 T.1.1.4 The Internet Goes International: Intellectual Property Considerations for Industry
Phillip L. Spector

567 T.1.2.1 Telecommunication in Slovak Education: A PSSC Legacy Project Helping Build Economy and Democracy in Slovakia
J. H. Southworth, Jozef Hvorecky

574 T.1.2.2 Creating an Inexpensive, Narrow-Band, Multifunction S/L-Band Earth Station for the Remote Pacific Islands: A challenge to the Industry, Carriers, and Funding Agencies
Bruce Best, Thomas Okamura

582 T.1.2.3 Implementing Convergent Telecommunication Technologies in Universities: How Cost-Effective, How Educationally Productive?
John M Renner

589 T.1.3.1 Designing Satellites for the Asian Region
David J. Whalen, Liang Sun-Liang

599 T.1.3.2 Trends and Applications of Satellite Operations in S.E. Asia
Roger Naff

604 T.1.3.3 The Need for a Mobile Satellite Terminal Design in Developing Countries: Mexico's Experience with Solidaridad
Luis Tellez-Giron

614 T.1.3.4 The Move to Ka-Band Satellite Telecommunications - An Assessment of Services, Availability and Performance
Louis J. Ippolito

621 T.1.4.1 Internet in China: Growth, Competition and Policy
Zixiang Tan

627 T.1.4.2 Evolving Telecommunications Regulatory Regimes in Developing Countries
Ben A. Petrazzini, Theodore H. Clark

635 T.1.4.3 Developing Competition in Local Fixed Networks in Hong Kong
M H Au

643 T.1.4.4 Local Number Portability - The Promises, And the Reality
Mike Heller

650 T.1.5.2 Telemedicine and Telehealth in the Pacific Islands Region: A Survey of Applications, Experiments, and Issues
Steven D. Bice, Greg Dever, Lori Mukaida, Scott Norton, Jimione Samisone

659 T.1.6.1 The Global Telecommunications Revolution: Building Both Information Super-Highways and Local Streets
Ryoichi Sugioka

662 T.1.6.2 Network Construction Plan for NII in R.O.C.
Steven Y. Chen, Duei Tsai

669 T.1.6.3 Future Directions for Telecommunications in Thailand
Philip Parker, Arthur Owen, Andrew Myles

674 T.1.7.1 Lotus Notes: The 90's Solutions for Telecom Carrier Business Expansion!
Larry Moore

684 T.1.7.2 Telecommunications Industry Dynamics
Massoud M. Saghafi

690 T.1.7.3 Televideo Business in Korea Telecom
Sungoh Min

698 T.1.7.4 Design and Implementation of an Enhanced Relational Database Management System for Telecommunication and Network Applications
Takashi Honishi, Nobuyuki Kobayashi, Jinnosuke Nakamura

Wednesday, 17 January 1996

707 W.1.1.1 Adding Value to Broadband Services
Reg Russ

713 W.1.1.2 Digital Technology for Program Contribution and Distribution in ABC Radio
Peter N. Kepreotes

721 W.1.1.3 High Quality Broadcast Television Transmission Based upon International Standards
Yoshiaki Nozawa, Toru Shibuya

729 W.1.2.3 ATM and Other Distance Learning Options at UC Santa Cruz
V.C. Marney-Petix

737 W.1.3.1 Remote Engine Inlet Simulation over ACTS: Why Aren't We There Yet?
Saragur M. Srinidhi, David E. Brooks, Steven C. Lin, Isaac Lopez~

743 W.1.3.2 Satellite Delivery of Wideband Service by ACTS
Douglas Hoder, Michael Zernic

752 W.1.3.3 Sharing Computational Resources and Medical Images Via ACTS - Linked Networks
David Y.Y. Yun, H. M. Chen-Garcia

760 W.1.3.4 Remote High Definition Video Post-Production Over High Data Rate Satellite: The U.S. Network Architecture
Larry A. Bergman, Burt Edelson, Neil Helm, James Pearman, Richard West, Frank Gargione

766 W.1.3.5 Remote High Definition Video Post-Production Experiment via Trans-Pacific HDR Satellite Communications Link : Experimental Systems in Japan
Naoto Kadowaki, Norio Shindo, Takashi Iida

772 W.1.4.1 The Future of the International Telecommunications Accounting Rate Regime
James Savage

781 W.1.4.2 The Impact of Boomerang Boxes and Callback Services on the Accounting Rate Regime
Robert M. Frieden

791 W.1.5.1 Telkom Indonesia: A Strategy Between Network-Based and Service-Based Expansion
B. Widjajanto, Agung Sutanto, Dodo Rukandi, Supriyo, Endang Susilowati, Sapri Sutisna

799 W.1.5.2 Cellular telephones and pagers in Hawaii: Cultural influences on personal use patterns
Dineh M. Davis

807 W.1.5.3 A Second Look to CTSC
Dario M. Goussal

815 W.1.5.4 China's EmergingTelecommunications Infrastructure: Market Analysis and Social Impact
Jerry L. Salvaggio

821 W.1.6.1 How Banks Reengineer Through Information Technology
Vatcharaporn Esichaikul

825 W.1.6.2 Remote Education Network via Satellite Utilizing 6.7 Mbps Digital Compressed Video
Takeo Imai, Atsuo Kashiwagi

831 W.1.6.3 New Information Communication Network In Multi-Media Age
Kuniko Shimizu, Takayuki Hirakawa

837 W.1.6.4 Two-way interactive advertising in the information society
Kazumoto Inuma

845 W.2.1.1 Internet Development in the Asia Pacific Region: Challenges to Implementation
Sarah S. Lee

852 W.2.1.2 Multipoint Videoconference System
Junichi Iizawa, Yukari Kamura, Teruo Katsumi, Makoto Miyazaki, Kazuhiro Kawamoto, Isao Masuda

859 W.2.1.3 A Proposed "Open Standards" Technique for Providing Interconnectivity Between the National Communication Satellites and The Global Broadband Satellite Networks
John F. Purchase

874 W.2.2.1 The Information Superhighway: Business Opportunity or Invitation to Disaster?
Joan Abramson

881 W.2.2.2 The Information Infrastructure: Opportunities and Decisions
John Spence

887 W.2.2.3 Videoconferencing Using VSAT
Dave Rehbehn

894 W.2.2.4 Mobile Business Applications - Examples of Global Applications Through Existing Satellite Networks and Those in Planning
Ramin Khadem

901 W.2.3.1 Software Opportunities in the Information Infrastructure
Saurabh Srivastava

904 W.2.3.2 Enabling Software Capabilities for the Global Information Infrastructure
Richard S. Wolff

912 W.2.3.3 Role of Intelligent Agents in the Information Infrastructure
Don Gilbert, Manny Aparicio, Betty Atkinson, Steve Brady, Joe Ciccarino, Benjamin Grosof, Pat O'Connor, Damian Osisek, Steve Pritko, Rick Spagna, Les Wilson

920 W.2.4.1 The Political Economy of India's Telecommunication Reforms
Nikhil Sinha

928 W.2.4.2 The Indonesia Approach to Developing an Information Infrastructure for the coming Multimedia Age
Aviadi H. Purnomo, Indra Utoyo

934 W.2.4.4 The Pacific Telecommunications and Information Infrastructure: Leap-Frog or Widening Gap?
Norman H. Okamura, Edmond Durand

948 W.2.5.1 Strategies for Working in Collaboration to Support Emergency Management Communications in the North, Central and Western Pacific
Christina Higa, Dave N. Kennard, Jerry B. Norris, Marilyn Shigetani

957 W.2.6.1 The Future of Private Submarine Cable: New Cables and Economic Opportunity
Neil Tagare

959 W.2.6.2 Mid-Range Undersea Cable System Applications for Emerging Markets
Kathleen A. Kurek, Elin C. Upperco

966 W.2.6.3 Fiber Optic Submarine Cable Systems: An Opportunity for Emerging Markets to Access the Global Highways and Super Highways
John Warta

972 W.2.6.4 Installation and Burial of a 240 Kilometer Long "ASN 14mm" Fiber Optic Telecommunication Cable in Bass Strait Using the "Ship-Of-Opportunity" Installation Technique
Michael R. Harrison, Brett Worrall

984 W.2.7.1 Financing the Global Information Infrastructure
Lionel H. Olmer

991 W.2.7.2 Taking Advantage of the Information Economy
Paul Mallam

997 W.2.7.3 Infrastructure: A Revisionist Plea
Donald M. Lamberton

1004 W.2.7.4 Financing for Development of Telecommunications Infrastructure: Various Means to Accumulate Capital for constructing and Enhancing Telecommunications Networks in Asian Economies
Mamoru Udaka

SUBJECT INDEX

Section	*Subject*
M-3.1 T-1.4 T-1.6 W-1.4	Accounting rates/tariffs
T-1.3 W-1.3 W-2.1	ACTS (NASA Advanced Communications Technology Satellite)
M-1.3	Afro-Asian Satellite Corporation (ASC)
M-1.3	AGRANI satellite system (ASC)
M-1.1	Alliances
M-2.1 W-2.2	ALOHA protocol
W-2.5	Amateur radio
M-1.3	AMPS
M-3.1	American National Standards Institute (ANSI)
M-3.1	AMSC
M-1.5	Apstar
M-1.4 M-3.5 M-3.6 T-1.1 W-2.7	APEC : Asia-Pacific Economic Conference
M-3.5 T-1.1	APII : Asia-Pacific Information Infrastructure
W-2.7	APT : Asia-Pacific Telecommunity
M-1.1 M-2.1 M-2.2 M-2.7 M-3.3 T-1.7 W-2.1	Area networks (LAN/WAN)
M-1.5 T-1.3	AsiaSat satellite system
M-2.1 M-2.2 M-3.3 T-1.6 W-1.2 W-1.3 W-1.5 W-2.1 W-2.4	ATM
M-1.7	Authentication procedure(s)
T-1.3 W-1.3	Bandwidth on demand
W-1.6	Banking technology
M-1.5 M-3.2	BER (bit-error ratio)
M-2.1 M-3.4 T-1.6 W-1.1 W-1.3	Broadband applications
M-1.5 M-3.3 T-1.6 T-1.7 W-1.1 W-1.3 W-1.5 W-2.1 W-2.4	B-ISDN
M-1.5 M-3.2	BPSK (bipolar phase-shift keying)
M-2.4 T-1.6 W-1.1	Broadcasting policy
M-1.1 M-1.5 M-1.6 M-2.4 T-1.3 W-2.1	Broadcasting satellite service (BSS)/ Direct broadcasting satellites (DBS))/ Direct-to-home (DTH)

M-3.3 W-1.1	Broadcasting technology
M-1.1 M-1.4 M-1.5 M-2.4 M-3.1 M-3.5 T-1.7	Cable television - CATV
M-2.2 W-1.4	Call back
M-3.7	Call data system (CDS)
T-1.3	C-band satellites
M-1.4 M-2.4	Canadian Radio-television and Telecommunications Commission (CRTC)
M-1.2 M-1.4 M-1.6 M-2.5 M-3.6 W-2.7	Capital investment and spending
M-1.3 M-3.1 M-3.4 W-2.1 W-2.2	CDMA
M-1.1 M-1.3 M-3.1 M-3.6 T-1.3 W-1.5 W-2.1	Cellular applications
M-3.1	CEPT (European Conference of Post and Telecommunications)
W-2.7	CITEL
W-1.1 W-1.5 W-2.1	CODECs (coder-decoder) for television or video

M-3.4 M-3.5 T-1.1 T-1.4 T-1.7 W-1.6 W-2.2 W-2.3 W-2.6	Commerce on the Internet
W-1.5	Community Teleservice Centers (CTSC)
M-1.4 M-1.5 M-2.2 M-2.6 M-3.5 T-1.4 T-1.7 W-1.1 W-1.5 W-2.4 W-2.6	Competition/privatization
M-1.5 M-2.4 W-1.1 W-1.6	Compression of digital signals
M-1.1	Computer aided design (CAD)
M-1.1	Computer-aided manufacturing (CAM)
M-1.1	Computer-telephone integration (CTI)
M-1.4 T-1.3 W-2.2	COMSAT
M-1.1	Concurrent engineering
M-1.1 M-3.4 M-3.5 M-3.7 T-1.2 T-1.6 T-1.7 W-2.4	Convergence
M-3.4 W-1.1	Copyright and patent laws

M-1.1	Country profiles
M-1.3	Courier satellite system
M-2.4 M-3.5 T-1.5 W-2.1	Cultural aspects
T-1.3 W-2.1	CyberStar satellite system
	DAB/DSB (see DSB)
M-1.1 M-3.2 T-1.3 T-1.7	Data communication services
M-1.2 M-3.7 T-1.7	Database services
M-3.7	Data warehousing
W-1.1	Digital sound broadcasting (DSB/DAB)
W-2.2	Decision analysis (DA)
M-1.5 M-2.1 M-3.2	Demand-assigned multiple-access (DAMA)
M-1.5	Demodulation
M-1.3 M-1.4 M-2.5 M-3.7 T-1.7 W-2.4	Deregulation
M-1.3 M-1.6 M-2.5 M-3.1 M-3.5 T-1.1 T-1.3	Development, applications/technologies

M-1.3 M-1.6 M-2.5 T-1.4	Development costs
M-1.1 M-1.2 M-1.3 M-1.6 M-2.1 M-2.2 M-2.5 M-3.5 M-3.6 T-1.1 T-1.3 T-1.4 W-1.5 W-2.1 W-2.4 W-2.7	Development, economic/political/social issues
M-1.6 M-2.5 M-2.7 M-3.5 M-3.6 T-1.4 W-2.1	Development, mutilateral/international policies
M-1.6 M-2.2 M-2.5 M-2.7 M-3.5 M-3.6 T-1.4 W-2.1	Development, national policies
M-1.6 M-2.5 M-3.5 T-1.1 T-1.3	Development, technology transfer
M-1.6 M-2.5 M-3.2 M-3.6 T-1.3 T-1.5 W-1.5 W-2.4	Development of rural infrastructure

M-1.5 M-3.2	Digital modulation techniques
M-1.5 M-2.4 W-1.1 W-1.6	Digital signal compression
	Direct broadcasting satellites (DBS) (see Broadcasting Satellite Service (BSS))
	Direct-to-home (DTH) (see Broadcasting-satellite service (BSS))
M-1.6 W-2.5	Disaster/emergency communications
M-1.6 M-2.5 T-1.2 T-1.3 W-1.2 W-1.5 W-1.6	Distance education/learning
T-1.3 W-1.3	Earth stations, advanced
M-1.3	ECO satellite system
M-1.4	EDI
M-2.1 M-3.4 M-3.5	Electronic commerce
	Emergency communications (see Disaster communications)
M-3.4	Encryption/scrambling
W-1.1	ETSI - European Telecommunication Standardization Institute
M-1.4	European Union
M-1.4 M-3.1 W-1.4 T-1.3 W-2.1 W-2.2	FCC

M-2.3 M-3.2 W-1.1 W-1.3	FEC (forward error correction)
M-2.1 M-3.2 W-2.1	FDMA (frequency-division multiple-access)
W-2.6	Fiber optic systems and hybrid systems
M-2.5 W-2.7	Financing and financial strategy
T-1.3 W-2.1	Fixed-satellite service (FSS)
M-3.1	Fixed wireless
W-2.6	FLAG submarine cable system
M-2.2 M-3.2	Frame relay
M-1.1	FTTC (Fiber to the curb)
M-1.1	FTTH (Fiber to the home)
M-1.6	Galaxy satellite system
T-1.1 W-2.7	G-7
M-1.4 M-3.6 T-1.1	General Agreement on Trade in Services (GATS)
W-1.3	Gigabit satellite network (GSN)
M-1.5 M-1.6 M-2.5 M-3.5 T-1.1 T-1.4 T-1.6 W-2.3 W-2.4 W-2.7	Global Information Infrastructure (GII)
M-1.3 M-3.1	GLOBALSTAR satellite system

M-1.3	*Gonets* satellite system
M-1.5 W-2.1	GPS (Global Position System)
M-1.3 M-3.1	GSM (Global System for Mobile Communications)
W-1.3	High-data rate earth stations (HDR)
M-3.4 W-1.3	HDTV/digital TV/high definition video
M-1.3 M-3.1 W-2.2	ICO satellite system
M-1.4 M-1.5 T-1.6 T-1.7 W-2.2 W-2.6	Information highway
M-1.6 M-2.6 M-3.5 M-3.7 W-2.2 W-2.3 W-2.4 W-2.7	Information infrastructure
T-1.3	Information services
M-2.4 M-2.6 M-3.5 W-2.7	Information society/economy
M-2.1	Information system(s)
M-2.7 M-3.4 M-3.7	Information technology (IT)
M-1.3 M-1.5 M-2.7 M-3.1 T-1.3 W-2.2 W-2.5	INMARSAT

W-1.5	Integrated Rural Development (IRD)
T-1.1	Intellectual property and IPR
M-1.4 M-1.5 M-2.7 M-3.1 T-1.2 T-1.3 W-1.4	INTELSAT
M-1.7 W-1.5 W-2.3	Intelligent networks
W-1.5	Intelligent terminals
W-1.6	Interactive advertising
M-1.1	Interactive media services (IMS)
M-1.1	Interactive television
M-2.6 M-3.1 M-3.2 T-1.4 W-2.1 W-2.7	Interconnectivity/interconnection issues
M-1.3 M-1.4 M-1.6 M-1.7 M-2.2 M-2.5 M-2.7 M-3.1 M-3.3 M-3.6 T-1.1 T-1.3 W-1.1 W-1.4 W-2.1 W-2.7	International Telecommunication Union (ITU)
M-1.1 M-1.2 M-2.7 M-3.2 M-3.4	Internet and Internet Services

M-3.5 M-3.6 T-1.1 T-1.4 W-1.6 W-2.1 W-2.4 W-2.6	Internet and Internet services *(Continued)*
	Internet protocols (see Protocols)
W-2.1	Inter-satellite links (ISLs)
M-1.4 M-1.5 M-3.6 T-1.4 W-2.7	Investment costs and strategies
M-1.3 M-3.6	Investment prospects
M-3.1 W-2.1	IRIDIUM satellite system
M-1.3	IRIS satellite system
M-1.5 M-2.2 M-2.7 M-3.1 M-3.7 T-1.6 W-2.1 W-2.4	ISDN and B-ISDN
M-3.4 T-1.1 W-1.1 W-2.1	ISO and IEC
M-1.3	Joint ventures
T-1.3	K-band satellites
M-1.3	KITCOM satellite system
T-1.3	L-band satellites
T-1.4 W-1.5 W-2.7	LDCs (Least or Less developed countries)

M-1.4 M-2.2 M-2.7 M-3.4	Legal issues
M-2.7	Legislation/Legislative framework
M-1.1 M-1.3 M-1.4 M-1.5 T-1.3 W-2.4	LEO satellite systems
M-1.1 M-1.4 W-2.4	Liberalization
M-1.2	Libraries (digital)
M-2.6 M-3.1	Licensing
	Local-area networks (LANs) See Area networks
T-1.3	Local multipoint distribution service (LMDS)
	Maritime satellite services (See Mobile satellite services)
W-1.5 W-2.6	Market analysis
M-3.7 T-1.7 W-2.2 W-2.7	Marketing strategies
M-1.3 M-3.1	MiniSat satellite system
M-3.6	Mobile network
M-1.3 M-3.1 T-1.3 W-2.2	Mobile satellite services (MSS)
M-1.5	Modems

M-1.5 M-3.2	Modulation techniques
M-1.1	MMDS
T-1.7 W-1.1	MPEG - Motion Pictures Expert Group
M-3.3	Multicasting
M-1.1 M-1.5 M-1.6 M-2.1 M-2.2 M-3.1 M-3.5 T-1.3 T-1.7 W-1.6 W-2.3 W-2.4	Multimedia
M-3.2	Multiple-channel-per-carrier (MCPC)
See MMDS	Multipoint, multichannel distribution systems (MMDS)
T-1.3	MSAT satellite system
M-3.5 T-1.1 T-1.4 T-1.6	National Information Infrastructure (NII)
M-1.4	Negotiating Group on Basic Telecommunications (NGBT/GATS)
	NAFTA (see North American Free Trade Agreement)
M-1.1 M-3.4	Netscape
M-1.4 M-1.6 M-1.7 M-2.1 M-2.2 M-3.3 T-1.6 W-1.3 W-1.6	Network architectures

M-1.7 M-2.7 M-3.5 M-3.7 T-1.7 W-1.5 W-2.3	Network management and network management systems
T-1.7 W-1.5	Network management terminal (NMT)
M-1.5 M-2.2	Network infrastructure
M-2.2 W-1.5	Network planning
T-1.3	Non-geostationary orbit satellite systems (NGSO/FSS and NGSO/MSS)
T-1.3	NorStar satellite system
M-1.4	North American Free Trade Agreement (NAFTA)
M-1.7 M-2.4 M-2.6 T-1.4	Numbering issues and system(s)
M-1.3 M-1.4 M-3.1	ODYSSEY satellite system
M-2.5 T-1.1	OECD (Organisation of Economic Cooperation and Development)
M-3.4	Open access
M-1.5 W-2.1	Open Systems Interconnection (OSI)
M-2.3	Optical amplifiers
T-1.3	OPTUS satellite system
M-1.3 M-3.1	ORBCOMM satellite system
M-1.2	Pacific Islands Business Network (PIBN)
M-1.5	PALAPA

M-1.4 M-1.5	PanAmSat
M-1.1	Pay-per-view (PPV)
M-1.1 M-3.4	Pay TV
M-1.2 T-1.2 T-1.5 W-2.4 W-2.5	PEACESAT
M-1.1 M-1.3 M-1.4 M-1.5 M-1.7 M-3.1 W-2.1 W-2.2	Personal communications (PCS)/FPLMTS
M-1.4	Personal communications satellite system
M-3.1	Personal handy-phone system (PHS)
M-2.4 M-2.5 T-1.4 W-1.4 W-1.5 W-2.1 W-2.7	Policy issues
M-1.5	PSK (phase-shift keying)
M-1.4 M-3.7 T-1.7 W-2.4	POTS
	Private sector investment (See investment costs and strategies)
M-2.3	Procurement issues
T-1.3	Propagation considerations (in space communications)
M-2.1 M-3.2 M-3.4 T-1.1	Protocols, Internet

W-1.3 W-2.1	Protocols, Internet (*Continued*)
M-2.1	Protocols, satellite software broadcast
W-2.1	PSDN (public switched data network)
M-1.5 T-1.6 T-1.7 W-2.1	PSTN (public switched telecommunication network)
M-1.1 M-1.2	Publishing and desktop publishing
M-1.5	QAM (quadrature amplitude modulation)
M-1.5 M-3.2 W-1.1 W-2.1	QPSK (quadrature phase-shift keying)
M-1.3	Radiocommunication systems
M-1.3	Railway telecommunication networks
M-1.5	Reed-Solomon techniques
M-2.2	Redial
M-2.2	Refile
M-2.2	Resale
M-2.6	Reciprocity
M-1.1 M-2.2 M-2.4 M-2.5 M-2.7 M-3.1 M-3.4 T-1.3 T-1.4 T-1.6	Regulatory issues
M-3.6	Revenue
M-1.5	RimSat

M-3.1 M-3.2 T-1.3 T-1.5	Rural and remote applications
M-1.6 M-3.2 M-3.6 T-1.3 T-1.5 W-1.5 W-2.4	Rural infrastructure development
M-1.3	S-80 TAOS satellite system
M-1.3	SAFIR satellite system
M-2.7 M-3.1 W-1.3 W-2.2	Satellite applications
M-1.5 M-2.5 W-1.3	Satellite communications, advanced
M-3.1	Satellite newsgathering (SNG)
	Satellite organizations (see EUTELSAT,INMARSAT,INTELSAT)
M-1.1 M-1.3 M-1.4 M-1.5 M-3.1 T-1.3	Satellite systems - LEOs and MEOs
M-1.3 M-3.1 M-3.2 T-1.3	Satellites systems, rural applications
W-1.3	Satellite technologies
T-1.3	S-band satellites
M-3.4	Scrambling/cryptography

M-3.4 M-3.5 T-1.1 W-2.1	Security issues
M-3.3	Service Node System (SNS)
	Settlement rate (See Accounting rates)
M-1.3	*Signal* satellite system
M-3.3	Signalling protocols
M-1.5 M-3.2 W-1.3	Signal-to-noise ratio, SNR (*Eb/No*)
M-1.5 M-2.1 M-2.7 M-3.2 T-1.3 W-1.1 W-2.2	Single-channel-per-carrier (SCPC)
M-1.6 M-2.1 M-2.4 M-2.5 M-3.5	Socio-economic issues
W-2.3	Software
M-2.2 T-1.6 W-1.3 W-1.5 W-2.1	SONET (Synchronous optical network)
M-1.2	South Pacific Forum
M-1.3 T-1.3 W-2.1	SPACEWAY satellite system
M-1.1 M-1.3 M-1.5 M-3.1 T-1.3	Spectrum management and allocation
M-1.7	SS7 network management

M-1.3 M-1.4 M-1.6 M-1.7 M-2.2 M-3.1 M-3.4 T-1.3 T-1.5 W-1.1 W-2.1 W-2.3 W-2.7	Standards or standards issues
M-2.2 M-3.6 W-2.4	Strategic alliances
M-1.6 M-2.3 W-2.4 W-2.6	Submarine cables and systems
M-2.3	Submarine optical amplifiers
M-1.7 M-3.3	Switching technology
M-2.2 W-1.5 W-2.1	Synchronous data hierarchy (SDH)
M-2.1	System integration
M-2.1 M-2.7 M-3.1 W-1.3 W-2.2	TDMA and satellite-switched TDMA
M-1.1	Teleconferencing
M-1.3 M-3.1 T-1.3	Teledensity
T-1.3 W-2.1	TELEDESIC satellite system
M-1.1	Telephony Services Application Programming Interface (TSAPI)

M-1.7 T-1.7 W-1.5 W-2.3	Telecommunication network management and Telecommunication Management Network
M-1.6 W-1.5	Telematics
M-1.6 T-1.3 W-1.3 W-1.5	Telemedicine, televeterinary
M-1.4	Telephone network
M-1.5 M-2.4 T-1.3 W-1.1	Television broadcasting
M-1.6 M-3.5 W-1.5	Telework/telecommuting
M-1.5 M-3.2	Thaicom satellite system
M-1.4	Time delay (in satellite systems)
M-2.7 W-2.1 W-2.2	Time-division multiplexing (TDM)
M-1.4 M-3.6 T-1.1 W-1.5	Trade issues
M-3.6	Traffic
M-2.5 T-1.4 T-1.7 W-2.4	Training/HRD
M-1.5	Transponder demand
W-2.1	Ultra small aperture terminals (USATs)
W-1.5	UNESCO

M-1.4 M-1.6 T-1.1 W-2.1 W-2.4	Universal service
M-1.1 M-1.4 T-1.3 W-2.3 W-2.6	Value-added services
W-2.1 W-2.2	Videoconferencing/teleconferencing
T-1.7	Video dial-tone services (VDT)
M-1.1 M-1.5 M-3.4 M-3.7 T-1.7	Video on demand
M-3.7	Videotex
M-1.2	Virginia Commonwealth University (VCU)
M-1.3	VITA (Volunteers in Technical Assistance)
M-1.5	Viterbi coding
M-1.7	Voice mail service
M-1.5 M-2.2 M-2.7 M-3.2 T-1.1 T-1.3 W-1.5 W-2.1 W-2.2 W-2.4	VSATs and VSAT networks
	Wide-area networks (WANs) See Area networks
W-1.3	Wideband services

M-1.1 M-1.3 M-1.4 M-1.7 M-3.1 M-3.5 M-3.6	Wireless communications and services
M-1.3 M-3.1 M-3.6	Wireless local loop (WLL)
W-1.5 W-2.7	World Bank
T-1.1	World Intellectual Property Organisation (WIPO)
M-3.1	World Radiocommunication Conference (WRC-95)
M-2.5 T-1.1 W-1.5	World Telecommunication Development Conference (WTDC/ITU)
M-1.4 M-3.6 T-1.1	World Trade Organization (WTO)
M-1.1 M-1.2 M-2.7 M-3.2 M-3.4 T-1.1 W-1.6	World Wide Web (WWW)
M-2.1 M-3.2 W-2.1	X.25 telecommunication protocol
W-2.1	X.400 telecommunication protocol
T-1.3	X-band satellites

COUNTRY AND REGION INDEX

Note:- Entries concern the country or region with regard to individual projects or within the context of a given analysis.

Section	*Country or region*
M-1.1	Africa
M-3.2	Alaska
W-2.4 W-2.5	American Samoa
M-1.1	Americas
M-3.6 T-1.1	APEC Countries (Asia-Pacific Economic Conference)
W-1.5 W-2.6	Argentina
M-1.3 T-1.1	ASEAN
M-1.3	ASEAN Cellular Satellite System (ACES)/Garuda
M-1.1 M-1.3 M-1.4 M-1.5 M-2.5 M-2.7 M-3.1 M-3.5 T-1.1 T-1.3 W-2.1 W-2.7	Asia-Pacific
M-1.1 M-1.2 M-1.3 M-1.4 M-1.5 M-2.6 M-2.7 M-3.5 M-3.6 T-1.3 W-1.1 W-2.1 W-2.4 W-2.6	Australia
M-1.6	Bangladesh
M-1.1 M-1.3 W-1.5 W-2.6	Brazil
M-1.5 M-3.6	Brunei
M-1.4 M-2.4 M-3.1 M-3.5 M-3.6 T-1.1 T-1.3 W-2.4	Canada
W-2.5 W-2.6	Caribbean
M-2.6 M-3.5 M-3.6 W-2.4 W-2.6	Chile
M-1.3 M-1.5 M-2.7 M-3.1 M-3.5 M-3.6 T-1.1 T-1.3 W-1.5 W-2.1 W-2.3 W-2.7	China
W-2.6	Colombia
M-1.1 M-1.3	Commonwealth of Independent States (CIS)
M-2.4 T-1.2 W-2.4 W-2.5	Commonwealth of the Northern Marianas (CNMI)

M-1.2 W-2.4	Cook Islands
M-2.6	Denmark
W-2.6	Ecuador
M-1.1 M-1.4 M-2.3 M-3.1 M-3.5 W-1.5 W-2.4 W-2.6	Europe/European Union
M-1.2 T-1.2 W-2.4 W-2.5	Federated States of Micronesia
M-1.3 W-2.4	Fiji
M-1.4 M-2.6	France
M-1.4 M-2.6	Germany
M-2.4 T-1.2 W-2.4 W-2.5	Guam
W-2.6	Honduras
M-1.1 M-2.5 M-2.6 M-3.1 M-3.5 M-3.6 T-1.1 W-2.4	Hong Kong
M-1.1	Iceland
M-1.3 M-1.5 M-1.6 M-2.6 M-2.7 T-1.1 W-2.3	India

W-2.4 W-2.7	India (*Continued*)
M-1.1 M-1.3 M-1.4 M-1.5 M-2.5 M-2.7 M-3.5 M-3.6 W-1.5 W-2.4 W-2.6 W-2.7	Indonesia
W-2.6	Italy
M-1.4 M-1.5 M-2.1 M-2.4 M-2.5 M-2.6 M-3.1 M-3.5 M-3.6 T-1.1 T-1.4 W-1.1 W-1.3 W-1.6 W-2.1 W-2.4 W-2.7	Japan
M-1.2 W-2.4	Kiribati
M-1.1 M-1.7 M-2.5 M-3.3 M-3.4 M-3.5 M-3.6	Korea
M-3.1 W-1.5 W-2.6	Latin America
M-1.4 M-2.6 M-2.7 M-3.1 M-3.6	Malaysia

T-1.1 W-2.7	Malaysia (*Continued*)
T-1.2 W-2.4 W-2.5	Marshall Islands
M-1.1 M-1.6 M-2.6 M-3.1 M-3.5 M-3.6 T-1.3 W-2.6	Mexico
M-1.3	Middle East
M-1.1	Mozambique
W-2.4	Nauru
M-1.2 M-1.4 M-2.6 M-3.5 M-3.6 T-1.4 W-2.4	New Zealand
W-2.4	Niue
M-1.4	North America
M-1.1 M-1.2 M-1.5 T-1.3	Oceania
M-1.2 W-2.4	Pacific Islands
M-1.2 M-1.6 T-1.2 W-2.4 W-2.5	Palau
W-2.6	Panama
M-1.2 M-1.5 M-3.5 M-3.6 W-2.4	Papua New Guinea

W-1.5	Paraguay
M-1.1 M-1.3 M-1.4 M-1.5 M-2.5 M-2.7 M-3.1 M-3.5 M-3.6 T-1.1 W-2.4	Philippines
W-2.4	Pitcairn
M-1.5	Polynesia
M-1.3	Russia/Russian Federation
M-1.3 M-1.4 M-1.5 M-2.5 M-2.6 M-3.6 T-1.1 W-2.3 W-2.4	Singapore
T-1.2	Slovakia
M-1.2 W-2.4	Solomon Islands
M-1.3	South Africa
T-1.3	Southeast Asia
M-1.3 W-2.6	Spain
M-3.6 T-1.1	Sri Lanka
M-2.6	Sweden
M-2.6	Switzerland
M-1.2 W-2.4	Tahiti
M-1.5 M-3.6 T-1.1	Taiwan

T-1.6 W-2.1 W-2.4	Taiwan (*Continued*)
M-1.1 M-1.3 M-1.4 M-1.5 M-2.2 M-2.7 M-3.5 M-3.6 T-1.1 T-1.6 W-2.7	Thailand
M-1.2 M-1.5 W-2.4	Tonga
M-1.2 W-2.4	Tuvalu
M-1.1 M-1.4 M-2.6	United Kingdom
M-1.1 M-1.4 M-1.7 M-2.6 M-3.1 M-3.2 M-3.5 M-3.6 T-1.1 T-1.3 W-1.2 W-1.3 W-1.5 W-2.4 W-2.6	United States
M-2.4	United States Pacific Territories
W-2.6	Uruguay
M-1.2 W-2.4	Vanuatu
M-1.1	Venezuela
M-1.2 W-2.4	Western Samoa
M-1.3 M-2.7	Vietnam
W-2.7	Vietnam (*Continued*)

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NOTES:

DOING BUSINESS ON THE INTERNET: AN EXAMINATION OF OPPORTUNITIES AND BARRIERS TO INTERNATIONAL TRADE AND COMMUNICATIONS

Paula V. Brillson
International Regulatory Attorney
MCI Telecommunications Corporation
Washington, DC, USA*

ABSTRACT

The Internet, and the World Wide Web, in particular, have been widely characterized as the next great frontier – technology that will revolutionize business interaction. While many companies ranging from interstate banks to local outlet stores are establishing their presence on the Internet, hoping to extend their existing businesses into cyberspace, few business transactions are actually conducted over the Internet. Critical issues concerning the commercial use of the Internet (including security, cost, reliability, access and ease of use) must be resolved in order for the Internet to emerge as an effective medium for commerce. This paper will describe how commerce on the Internet got started, examine opportunities and obstacles for electronic commerce and review government and private sector initiatives to foster the development of the Internet as a viable marketplace.

I. INTRODUCTION

The Internet, connecting millions of computer users worldwide, promises to take commerce and global communications to a new plateau. The grand vision is that by the year 2000 the Internet will be the major hub-site for international commerce where virtually unlimited information and services will be at the fingertips of every user. In fact, this past year alone, the innovation of the World Wide Web (the "Web") a client/server system based on a new set of protocols, has helped revolutionize the Internet by delivering an increasing variety of multimedia applications, including colorful graphics, single keystroke interactivity, sound and even voice.

The Internet is quickly gaining acceptance by banks, financial services providers, educational institutions, travel agencies and retail establishments, as a cheap means to distribute marketing and advertising information. By setting up a presence on the Web, commonly referred to as a "Web Site," a company's on-line message could potentially be accessed by a worldwide network of over 40 million users. While industry analysts predict that the World Wide Web will transform the way we do business and communicate with one another in a way that may prove more profound than the coming of television, there is much uncertainty as to how to make it a viable buyer/seller marketplace. Chief among these concerns are issues of security, reliability, cost, access, ease of use and quality of service.

Enormous resources have been dedicated by government to resolve the critical issues concerning the commercial use of the Internet including those undertaken by the United States (NII/GII), ITU (BA Declaration), G-7, the OECD and APEC through the APII, as well as by the private sector to ensure the development of a secure, trusted and functional network. The development of comprehensive policies and standards is crucial, not only to the development of the Internet, but to the growth of the telecommunications industry, as a whole.

This paper will describe how the introduction of a user-friendly set a protocols, such as the World Wide Web, has given rise to significant opportunities for global commerce on the Internet. Further, it will examine issues which are critical to the development of the Internet as a viable marketplace, such as security, cost, and access. and explain how these concerns are being actively addressed and, in some instances, resolved through government and private sector initiatives, with a specific emphasis on the United States and Asia.

II. COMMERCIALIZATION OF THE INTERNET

In the nascent years of the Internet, the network was relatively unstructured. Navigating through the network's fragmented resources required the user to input a series of complex string commands to access its intelligence thus, "naturally" limiting the community of Internet or "Net" surfers to highly computer literate individuals such as engineers, programmers and academics.

With the creation of a new set of protocols such as the Web, the Internet has been transformed into a mass market user-friendly environment. Clicking a mouse on highlighted words and icons now allows a user to "hyperlink" to related information or access sub-topics and then return to previous pages without ever needing to type out any commands or file names. In fact, one might say that the Web has revolutionized the Internet in much the way Apple revolutionized the computer industry -- by taking the "tech" out of "technology" and making the product easy to use.

At this point in its development, the Internet is far from perfect. Largely unedited, much of the information you may find on the Internet is uninteresting, foolish or just flat-out wrong. While there is clear potential of the Internet as a new medium for commerce, too many questions are still unanswered about how to make it a viable marketplace. Many speculators in the Net believe that true electronic commerce between companies is still five years away, in the interim, companies are rapidly putting promotional material on the Web as an inexpensive way of getting public exposure on the Internet.(1)

MCI has already taken an initiative to capitalize on the opportunities created by the Internet with its announcement in November, 1994 of "InternetMCI", an ambitious plan to substantially expand the commercialization of the Internet beyond its estimated 40 million users. Its plans to exploit the Internet include an electronic shopping mall and enhanced E-mail and a host of other on-line services, some of which will be created and distributed through a partnership initiative with News Corp. AT&T announced in August, 1995, its plans for a nationwide Internet service, dubbed "Worldnet" which will provide, to its existing telephone customers, information services, electronic mail, voice and video conferencing and wireless access. Big-brand advertisers have recognized the value of the Internet audience and have developed "interactive ads" that engage the consumer in dialogues that provide useful information to the consumer, while at the same time, direct the consumer to divulge valuable marketing information about themselves. Club Med, for example, lures on-line consumers with its colorful illustrations of Caribbean resorts to answer a few questions at the outset and then focuses the message on the user's particular interests based on their responses.(2)

III. OVERCOMING OBSTACLES FOR ELECTRONIC COMMERCE

While many companies have taken the lead in the electronic commerce revolution by merely establishing a presence on the Internet, the next leap forward to exploit the potential mass market opportunities poised by the Internet will necessitate the resolution of a myriad of issues including security, privacy and access, as well as universal service requirements. Governments, through participation in multilateral organizations, including the ITU, OECD and the ISO and the development of global initiatives such as the Global Information Infrastructure ("GII") are engaging in a consultative and cooperative process to ensure the development of the GII will be to the mutual benefit of all countries.

a. AVAILABILITY OF MARKET DATA

One private sector initiative that has been undertaken as a way to promote commerce on the Internet and respond to industry's desire for data and statistics about its users was a survey conducted by A.C. Nielsen Company, sponsored by CommerceNet, a non-profit consortium of companies and institutions promoting commerce on the Internet. The survey, conducted via telephone, consisting of forty multiple-part questions, focused on demographic information of approximately 4,200 individual users within the United States and Canada, the types of services they access, the time they spend on-line and whether they purchase any products or services over the Internet. The results of the survey, revealed that Internet users average 5 hours and 28 minutes per week on the Internet. Males represent 66% of Internet users and account for 77%of Internet usage. On average, Web users are upscale (25% have incomes of over $80K), professional (50% are professional or managerial), and educated (64% have at least college degrees) and approximately 14% (2.5 million) of Web users have actually purchased products or services over the Internet.(3) This research clearly represents an important milestone in the measurement of the Internet and Web usage. For the first time, scientific data has been made available to promote an understanding of the use and possibilities of the Internet-based commerce.

b. SECURITY

The lack of security on the Internet is a major obstacle prohibiting the Internet from advancing from trial marketing activities to widespread commercial transactions. Data sent via the Internet is still inherently unprotected -- that is, the information is capable of interception by another user or through government "espionage" (i.e., national security activities). For this reason, most consumers would not consider using the Internet for commercial activities at this stage of its development. In fact, a recent Ernst & Young study concluded that more than half of the 1,271 companies polled had incurred losses due to lack of computer security. In some ways, the fear of conducting transactions and making retail purchases over the Internet is irrational, considering that many consumers will casually give credit card numbers to faceless operators over the telephone. While the potential for unauthorized use of credit information is less on the Internet than in telemarketing operations, people are still not used to the idea of providing it to the same company's Web Site. Until Internet users are confident that the Internet environment is a secure place, they will not be inclined to conduct financial or personal transactions electronically.

Internet security issues generally involve three components:

- Confidentiality. Messages sent over the Internet are broadcasted over a network and are vulnerable to being (intercepted) picked up by other users.

Strong encryption has the capability of providing the needed means of security by coding data into a form that can only be read by the receiver using a secret decryption key.

- Integrity. A message is sent over an open network connected to millions of other terminals. There is no assurance that the message will actually be delivered to the intended recipient or will not be altered on route to its destination.
without presenting a barrier to intelligence

Software systems are available that would enable a user to detect whether information has been tampered with.

- Authenticity. Since one computer is communicating with another computer, there is no way to be certain of exactly who you are dealing with, unlike the traditional face-to-face meeting, telephone exchange or fax communications that provides signals for recognition (face, voice, signature).

Authentication could be achieved by associating a unique cryptographic key with a user. Further digital-signature technology is available to authenticate transactions (e.g., electronic funds transfers by or between banks).

Since much of the information that must be provided to facilitate a business transaction is sensitive, electronic commerce will not be possible if the elements of confidentiality, integrity, and authenticity are not built into the Internet. To combat the problem of network security, restrictions on sophisticated data encryption products which have been imposed by U.S. government for reasons of national security are being loosened in response to pressure from both users and vendors. In fact, new policy initiatives may allow export of products with encryption keyed up to a 64-bit key size.(4) This move by the U.S. government should provide the impetus for vendors to move onto the Internet to conduct commercial transactions. However, the removal of regulatory barriers to the exportation of encryption technology, in and of itself, does not necessarily ensure that the products will be permitted entry in a particular market. Spain, for example, heavily restricts the import of encryption technology while failing to offer viable domestic alternatives. Promoting the development of the GII and meeting the needs of businesses and consumers will require all countries to embrace policy directives that will make available strong, flexible encryption standards, that, at the same time, respect the legitimate needs of national security and law enforcement.

c. COST/ACCESS

Another uncertainty of doing business on the Net is cost. As the Internet gets bigger (both in terms of users and service sophistication) and demands more bandwidth, it has drawn the attention of the traditional telecom providers and the pressure is on to convert from flat-fee, unlimited usage charges to a usage based cost structure. This is likely to have a profound effect because one of the greatest attractions of the Internet has been its low cost/price access.

In countries such as India, until quite recently, doing business, or even conducting basic communications on the Internet was cost prohibitive. India's Department of Telecommunications imposed excessive initial licensing fees on nationwide e-mail providers and other providers of basic business services which was quickly withdrawn after Sprint and other Internet access providers refused to pay the hefty fees and proceeded to initiate services.(5) Under a new service offered by the state-owned Overseas Communications Corporation through MCI Communications Corporation, anyone can now subscribe for 5,000 rupees (US$160) for access to all Internet facilities for up to 250 usage hours--commercial users are charge four times more.(6) Companies are hoping that the Indian government will be pressured to lower costs even further and thus minimize regulatory interference, on a whole, as product availability and costs of obtaining network links are decreasing.

Similarly, in China, the potential of the Internet is just being realized, as high costs and limited accessability have prevented most citizens from exploring the Net. Established in 1993, the Institute of High Energy Physics in Beijing remains the only Internet gateway in the country. The Internet in China, dubbed, "the China Internet Project" is administered by the Ministry of Post and Telecommunications (MPT) who is responsible for providing Internet access to 600 cities in China, including 360,000 state enterprises and 8.6 million commercial entities. Opening an Internet account in China costs about $US125, with a $US per month usage charge plus phone charges. Phone access is also a problem in many parts of the country, even though 10 million lines have been installed in recent years. (7)

Trade barriers and market constraints have always hindered the development of a unified global economy. This we have seen and continue to confront in the telecommunications industry as a whole (e.g., high tariffs, restrictions on competitive service provisions in countries whose telecommunications marketplaces are dominated by government-owned monopoly PTTs and excessive accounting rates). In order for global commerce on the Internet to succeed and flourish, a shift in the traditional narrow sovereignty-approach to telecommunications regulation must occur. And this will continue to prove perhaps the most formidable barrier.

The governments of China, Taiwan and Hong Kong have made recent strides toward loosening the restrictions currently placed upon access to the Internet. Taiwan is considering legislation to turn commercial responsibility for the Internet over to the National Information Infrastructure (NII) while removing Internet access responsibility from the Directorate General of Telecommunications (DGT), which has been criticized for its poor service and high rate schedule.(8) DGT charges customers a US$16 per month plus US$1 per megabyte to download data. Taiwan, however, continues to require that Internet access providers be 100% Taiwanese-owned operations. Currently, only three commercial Internet access provider licenses have been granted by the government, although reportedly, there are 1,000 unregistered entities providing access to bulletin board services and even on-line stock quotes.

Similarly, the government in Hong Kong, who reportedly closed down about 30 Internet providers who did not possess the proper regulatory documentation -- even though such documentation had never been required, recently allowed those providers to reopen and gain legal status. In addition, Hong Kong's Economic and Trade Office has established a Web Home Page to provide users access to Hong Kong economic and business information.(9)

Basic economic principles indicate that if suppliers are permitted market entry, costs and prices for services will be driven down in both the short and long term. Yet, the unfortunate reality is that many incumbent monopoly providers fail to embrace a new paradigm to permit private competitive forces to develop infrastructure and introduce new services. While the majority of people residing in developed countries are gearing up to exploit the enormous resources the Internet offers and are already linked to the vast "network of networks," in contrast, most people in developing countries continue to await the installment of their first telephone in their communities, let alone direct telephone access from their homes. In order for the information revolution to achieve the objective of establishing widespread, if not universal network expansion, sector reform initiatives such as privatization, licensing of new carriers as well as the

601

formation of strategic partnerships must rapidly emerge to replace the traditional monopoly-provider approach to telecommunications deployment.

d. UNIVERSAL SERVICE

As the Internet grows into a global information machine, fundamental changes are taking place -- in the sky, underneath our sidewalks, across our telephone poles, where satellites are being launched and fiber optic and coaxial cables are being introduced to replace copper wire to meet the ever growing demand for information-carrying capacity and bandwidth. The provision of universal service continues to be one of the most popular policy objectives, as evidenced by its inclusion in virtually every public sector domestic and multilateral initiative (including the GII, the BA Declaration, the G-7 and the APII). Although new definitions for the term "universal service" continue to evolve, the basic assumption underlying this concept is "services delivered to each household." Because the ability to access information and the speed at which information can be retrieved is critical for business, health, education sectors and government, the challenge of promoting the development of international, regional and national networks, can not be met by solely relying on national regulators to implement standards for universal service requirements among all carriers via access charges or mandatory universal service funds. International approaches are also needed to coordinate among the various, and frequently incompatible, domestic regimes.

As monopolies on local telephone service are being challenged by newly licensed competitive carriers, the method by which most traditional (universal) phone services has been funded will also require change. Because most will agree that the Internet service should be globally inclusive and widely participatory, universal service goals remain critical. One of the biggest problems with universal service plans with regard to the Internet is that no one knows what the core of the information highway will be. Fiber to home? Video on demand? Interactive distance learning curricula? Even if we could define the Internet in concrete, absolute terms, what would the "essential services" of the Internet consist of? While no one can accurately predict what services will develop over the nascent broadband network, one thing is for sure, Internet connectivity will pervade our every day lives and transform the way we work, learn, and communicate. In this context universal service may mean ensuring that all communities have reasonable access to this process. Unfortunately, most PTTs and their regulators have failed to provide even basic telephone service to the majority of their citizens. Of course they have only had about a hundred years to get telephone densities up to the current world average of 4 lines per 100 persons.

The best practical approach to achieving universal service goals is to not retard the development of Internet and its accompanying services and resources simply because government has not yet devised laws and regulations to address the unique issues the Internet raises. Universal service begins with a telephone in every home -- this is a first step that eventually lead to Internet access.

III. CONCLUSION

For some would-be-users, the Internet remains merely a media scam, likened only to Orson Welles' notorious 1938 "War of the Worlds" radio broadcast ("Martians have just landed in Grovers Mills, New Jersey!"). Others who have access to a personal computer and high-speed telecommunications links to the Net, know first hand that the technological revolution has, indeed, arrived.

Notwithstanding the uncertainties surrounding the future of the Net, slowly, but surely, leading edge corporations and entrepreneurs are beginning to fill the vacant spaces of the Network's seemingly limitless capacity with their customized Web pages, seizing the opportunity as a virgin medium for selling their wares or marketing their services. As ongoing efforts continue to improve the existing transactional, technical and regulatory standards, there is no denying that a new medium has arrived and it is bringing about a change in the way we do business.

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* The opinions expressed herein are those of the author and do not intend to reflect the opinions or positions of MCI.

1. "Purchases on the Internet 'could potentially exceed $200bn by year 2000," Financial Times, November 1, 1995, at 12.

2. "Just Click to Buy," Time Magazine, Special Issue: Welcome to Cyberspace, Spring 1995, at

74.

3. The CommerceNet Nielsen Internet Demographics Survey, Executive Summary, Copyright © 1995, CommerceNet Consortium/Nielsen Media Research.

4. "White House Relaxes Export Rules on Encryption," Computerworld, August 21, 1995, at 8.

5. Under the Indian Telegraph Act of 1885, the Department of Telecommunications has the power to build, license and monitor telecommunications networks. The Act, in part, even provides the Department with the authority to intercept messages without a court order in the "interest of public safety."

6. "India Allows Public Access to the Internet Network," Wall Street Journal, August 16, 1995, at A6.

7. "Asia Loosens Internet Access. (Taiwan, Hong Kong and China Add Internet Access.)" Electronic Engineering Times, August 7, 1995, at 68.

8. Id. The article reports that a test network in Hsinchu will provide videoconferencing, automated customs clearance and on-line shopping. In addition, a similar test network in Taipei will provide a telemedicine, cable TV and a multimedia database.

9. "Hong Kong Government Opens Internet Gateway to Asian Business; Economic and Trade Office Launches World Wide Web Home Page to Provide Net Users Easy Access to Hong Kong Economic and Business Information," Business Wire, May 15, 1995, at 51.

WRAPPED UP IN THE NET:
THE INTERNET COMES TO ASIA

JEANETTE K. CHAN
Paul, Weiss, Rifkind, Wharton & Garrison
Hong Kong

I. INTRODUCTION

Several months ago, a young girl in a village outside Beijing was attacked by a strange and debilitating disease that literally seemed to be eating her alive. None of the rural doctors who treated her could diagnose the disease, so they rushed her to Beijing for treatment. Yet, the doctors in China's capital were also stumped by the mysterious illness. In desperation, the doctors put out an urgent message along the invisible and somewhat mysterious Internet, to which they had only recently been connected. In the message they placed onto the Internet's health bulletin boards, the doctors described the girl's systems and pleaded with the unknown persons who they hoped might receive their message for advice.

Within minutes of sending their message out into cyberspace, a doctor in Hong Kong saw their plea for help and relayed back a preliminary diagnosis. Indeed, within a week, the Beijing doctors received over 200 responses to their request from doctors and scientists all over the world, including an accurate diagnosis of the rare flesh-eating bacteria that was afflicting the girl, a diagnosis that saved her life.

Perhaps no story better illustrates the tremendous potential of the Internet to share knowledge and information and truly bring the world closer together than this one. Only a few years ago, the Internet and the information superhighway were terms unknown in Asia. Today, however, Asia's students and young entrepreneurs are abuzz over the potential of the "Net" to provide information, improve economic efficiency, and offer links to the outside world. While Asia still is home to less than one tenth of the world's Internet domains, the growth in Internet users throughout the region in the last two years has been exponential, and all industry experts predict this growth to continue for quite some time.

In this presentation, I will discuss the rapid growth of Internet use in Asia, the diverse current uses of the Net in the region, the region's commitment to building an information infrastructure, and finally the future of the Internet in Asia.

II. GROWTH OF THE INTERNET IN ASIA

Virtually unknown in Asia in the early 1990's, the Internet has experienced extremely rapid growth over the last two years. Today, the Internet is one of the hottest topics in Asia: the subject of much debate among the region's governments, curiosity among its citizens, and commercial interest among its businesses.

Culturally, the Internet is chic and trendy. In Japan, where within the last year, the number of Internet domains has nearly tripled from 38,000 to 100,000, the country now boosts over one million users. Young Japanese, whose interest in the Internet has out paced their ownership of personal computers, have popularized Internet cafes where they can meet for lunch, sip imported beer and surf the Net on computers provided by the cafe. In Hong Kong, Internet access has become so competitive and lucrative that over 35 companies are now competing to provide Internet access, and in a symbol of how mainstream the Internet has become, some service providers are spending large sums to buy advertisements on the colony's Mass Transit Railway. Even in China, where access to the Internet is much more closely regulated by the government, the number of host computers has risen from only 400 in March to 12,000 by November -- a remarkable 30-fold increase.

In the ASEAN countries of South East Asia, Internet use is also growing at a breakneck pace. In early 1994, none of the ASEAN countries had private Internet service providers, but by now, Thailand, Malaysia, Singapore, the Philippines, and even Sri Lanka all have already permitted or are in the process of licensing private Internet service providers. Singapore, for example, has recently licensed its third Internet service provider, Cyberway, and the Singaporean Government expects that a quarter of a million users in Singapore will be on-line by the end of the decade. In Thailand, the government has declared that the Internet must be made available to as many citizens as possible in order for the country to remain competitive in the information age. The country's first commercial Internet provider began operation only last March, but today there are more than 50,000 Thais using the Internet regularly. The Lanka Internet Service Ltd. of Sri Lanka launched its service in April of this year, and is connected to the Internet through lines leased from Sri Lanka Telecom.

Two of the major causes of this growth have been the development of the World Wide Web and recent software breakthroughs in non-English language programs. The World Wide Web, where the number of home sites has been doubling every two months, offers the possibility of combining graphics, video and text in a format that is easy to search and access. And, recent software developments have done much to facilitate Internet usage among non-English speaking countries.

For many years, software problems greatly limited the use of scripts that do not use Latin characters, such as Chinese, Japanese, and Thai. Incompatibility among various types of Japanese software, for example, meant that Japanese language messages transmitted over the Net often appeared in garbled form on the receiving end. New software, however, has done much to alleviate these incompatibilities. Indeed, Chinese language users of the Net have gone so far as to put software on public domain (i.e., make it freely available to Net users) so as to ensure compatibility among various Chinese-language programs. If the Unicode coding system, where capacity for transmitting characters is 500 times greater than the standard ASCII code, becomes more widely accepted, communication in non-Latin scripts will become even easier.

Just recently the font company Bitstream announced the marketing of Cyberbit, a new multilingual font that includes every major language including Japanese, Chinese, Korean and more. Likewise, in a development that demonstrates how international use of the Internet has become, Netscape Communications has already begun to distribute Netscape Navigator 1.1, the world's most popular tool for Web browsing, in Japanese, German and French versions. And, in a display of how software has facilitated on-line communication in languages like Chinese, the first radio scripts that Voice of America has chosen to put on-line are its Chinese-language broadcasts.

English speakers who enjoy the fact that English is the lingua franca on the Net need not fear the growth in other languages. English will not be in anyway displaced, but rather other languages will grow up alongside English and offer to speakers of those languages the same opportunities for communication and information retrieval as English speakers currently enjoy. Indeed, it is in no way farfetched to envision in the near future that companies who establish World Wide Web home pages will set up home sites in different languages to allow persons who wish to gain information about these companies to obtain information in whatever language they desire.

Efforts to develop an intra-Asian backbone for the Internet will also speed its development in Asia. Currently, if a bank in Japan wishes to send an e-mail message to a branch in Hong Kong, the digitized message bounces across the Pacific from Japan to the United States and back to Hong Kong.

This inefficient system for inter-Asian communication congests the expensive trans-Pacific lines and offers a slower performance than is otherwise possible. To deal with this problem, Internet service providers in Asia have begun to map out a blueprint for an Asian Internet "backbone" that would keep much of the inter-Asian traffic within Asia -- meaning faster access, better response, and less congested international links.

An effort launched in October by an Asian consortium known as Asia Internet Holdings, made up of Hong Kong SuperNet, Pacific Internet, and two Japanese companies -- Sumitomo Corp. and Internet Initiative Japan-- will target corporate Internet users and service providers. AIH will connect its Tokyo hub with hubs in the United States, Singapore, and Hong Kong. Other Asian countries will have smaller hubs connecting them to the backbone and from there to the other countries via a high-speed pathway. In a statement announcing the formation of this Asian backbone, the partners stressed the fact that "[m]any multinational corporations operating in Asia are looking upon the Internet as the platform on which to build their own private networks linking offices, factories and staff all over Asia and the world."

Realizing the demand for an Asian Internet backbone, AT&T has also announced a plan to establish an Internet service hub in Hong Kong as part of a drive to connect the Asia-Pacific with a high-speed communications backbone based in the region. The AT&T service will offer customers the ability to access their personal account in more than 150 cities by dialing a local number provided for the purpose by AT&T, thus eliminating the need to make expensive international calls.

III. USES OF THE NET

Today, a student in Hong Kong can correspond with a friend across the Pacific Ocean in California in minutes. A woman in Tokyo can order a handbag from an international on-line mail-order firm. And, Australian tourists, hunting for potential eateries during their visit to Malaysia, can browse the Hard Rock Cafe Kuala Lumpur home page while sampling 10-second audio and video clips of the Cafe's featured singers. Has the modem replaced the mailman? Have computers supplanted catalogues? Perhaps not quite yet, but the extent of electronic mail and digital commerce hints that day may be coming -- and sooner than we expected.

The Internet gained initial popularity by offering users the quick and inexpensive method of sending and receiving electronic messages known as e-mail. E-mail, by far the most popular use of the Internet, has become a close friend to business people, academics, and many others, for it is among the world's cheapest and fastest means of communicating. Under most current Internet pricing schemes, users are charged only for the amount of time they are on the Internet and not for the distance of their communications. Sending a message halfway around the world by e-mail is, in many cases, cheaper and faster than hand-writing and delivering a message halfway down the street.

E-mail has been most popular with students who communicate with friends around the country and with electronic pen pals at universities abroad. Recently, more and more business people are seeing the potential savings attached to Internet communication, and e-mail addresses are rapidly taking their place below fax numbers on business cards throughout Asia. For businesses, electronic mail means lower postage, fax and telephone costs. Moreover, companies and law firms on the net using a file transfer protocol can exchange very lengthy files and substantial amounts of data very quickly and inexpensively.

Take my firm as an example. Paul Weiss has offices in New York, Washington D.C., Tokyo, Paris, Hong Kong and Beijing. As of the date of this article, all the offices, other than Beijing, are connected to the Internet and use e-mail for internal communication. We are very proud of the fact that, with our offices operating in different time zones, we are able to provide 24-hour service for our clients. Our Hong Kong office, for example, can ask our New York office to assist in the preparation of a document at the close of our work day and we can retrieve it from New York via e-mail the next morning. It is a very inexpensive and efficient way to conduct a legal practice.

While up until now e-mail has generated the most interest in the Internet, businesses are now beginning to investigate how they can complement the communication boom with an economic boom of their own. The source of keenest interest has been the World Wide Web. Be it sales of tickets to upcoming performances at the Hard Rock in Kuala Lumpur or sales of sporting goods, more and more business is being done on the Internet, and as encryption software improves and allows for secure communications, the amount of business will grow far more rapidly.

The push for improved encryption software reinforces the notion that economic opportunity has become a driving force behind much of today's Internet innovation. Already, stores in Malaysia are opening their own electronic storefronts on the World Wide Web -- storefronts that with the proper graphics and detail-- may entice the "electronic browser" into doing business. This development is a result of a strategic alliance between SCI Asia Connect, a Malaysian Internet service provider, and eShop, a U.S.-based company specializing in developing and distributing software for the creation of electronic shops. Under terms of their agreement, SCI Asia Connect will distribute eShop software free of charge to store-owners in order to help them establish their electronic storefronts. By providing Asian companies the opportunity to open up electronic storefronts on the Internet, SCI Asia Connect anticipates allowing Asian vendors and customers to tap into the vast Internet market.

An even more far-reaching experiment is that being attempted by Singapore's SilkRoute Ventures, which, through their Asia OnLine Internet publishing business, helped establish the world's first virtual trade fair on the Internet. For US$400, companies can set up a table for one year at a virtual exhibition where Web users can "walk through" various booths, exploring objects and finding out information about certain models, without leaving the comfort of their own living room. While companies have been slow to respond to the project, organizers believe that once the initial hesitation to become involved in such a new project recedes, companies will realize that virtual trade exhibitions can help the exhibition industry cultivate a new community for trade show organizers and exhibitors. Virtual trade shows are just the beginning of a more ambitious goal for many businesses operating on the Internet: the virtual mall.

Several years ago, the home shopping craze swept the United States, and today, there are several home shopping channels on many cable networks throughout the U.S. Many business people in the U.S., Asia, and around the world, are predicting that interactive, consumer-directed home shopping on the Net will become an even bigger business than the multi-billion dollar television home shopping business. Although current technology does not provide the necessary security for allowing cash or credit transactions on line, new technologies promise to offer consumers the ability to sit at their computers, look at whatever products they wish to purchase, and then merely to press a button to make an electronic payment. The concept of such an international virtual shopping center is a very attractive one to Asia's dynamic entrepreneurs, and, to a certain extent, some shops are already open for business.

In Japan, the marketing success of the Do-it-Yourself Import Center has been a model that other companies may wish to emulate in the near future. The Oregon-based Do-It-Yourself Import Center allows clients to place ads for, and images of, their products on the Internet without having to pay rising postage and printing costs. Consumers in Japan have used the service to order everything from computer software to sporting goods. Marketers are finding that in addition to providing low-cost access to some of the world's most affluent customers, Internet marketing allows them to capture names and addresses by e-mail, thereby removing the need for labor-intensive data work normally associated with building prospect lists.

While the Web currently holds great promise for private enterprise, it is also attractive to governments. In some countries in Asia, one of the greatest difficulties in doing business is a lack of access to public information, whether it be in the form of raw economic data or government laws and regulations. The Web offers the opportunity for

607

local governments to publish laws, regulations, data, contact persons, and responsible organizations in a manner highly accessible to interested parties. Such an increase in the transparency of government and access to information would be a great attraction to investors and other persons wishing to do business with particular countries. Seizing on this concept, Vietnam has, for example, recently placed its new Foreign Investment Code on-line for prospective business persons to examine.

Equally important is the Internet's educational potential, and in particular, the access it offers to a treasure trove of information. Teachers with access to the Net can simply plug in their computer and offer students the resources of university libraries worldwide. Another educational possibility the Internet promises in the near future is students joining discussion groups or real time on-line classes with their counterparts on the other side of the globe, forever altering current concepts of foreign language study. Recognizing the potential educational benefits of the Internet, Singapore, for example, has announced that the public will be able to access the Internet for free from any of its ten national libraries.

IV. APEC'S COMMITMENT TO CONSTRUCT AN ASIAN PACIFIC INFORMATION INFRASTRUCTURE

The importance Asian countries now place on developing an extensive information infrastructure was clearly demonstrated at the Ministerial Meeting on Telecommunications and Information Industry of the Asian Pacific Economic Conference (APEC) in Seoul, South Korea on May 29-30, 1995. At this first-ever region-wide telecommunications summit, ministers responsible for telecommunications and the information industry stressed the importance of a solid information infrastructure in spurring economic growth. For decades, Asian governments had viewed communications infrastructure as less important for economic development than other forms of physical infrastructure such as electric power, transportation and heavy industry. APEC ministers at Seoul, however, stressed the vital role played by the information and telecommunications industries in the modern economy and noted that the "information infrastructure disparity among member economies" has "kept APEC members from sound and sustainable economic development in the region."

In order to accelerate the development of an information infrastructure throughout the region, APEC ministers committed themselves to constructing the Asian Pacific Information Infrastructure or APII. Among the goals of the APII are to facilitate the construction and expansion of an interconnected and interoperable information infrastructure in the region; encourage technical cooperation among member economies in the development of the infrastructure; and promote a free and efficient flow of information. During the conference and the working group meetings leading up to it, ministers referred to the Internet as a model for interconnection among members' individual information infrastructures. The views of the APEC representatives demonstrated the degree to which the Internet has come to be viewed not solely as an American system or as a device for linking Asian economies with America's but rather as a viable tool for interconnecting Asian countries among themselves.

One of the most notable aspects of the Seoul Declaration was its emphasis on the role that the private sector should play in developing the Asian Pacific Information Infrastructure. The need for private sector participation has been a fundamental principle of the United States Government in promoting America's National Information Infrastructure (NII). Likewise, the G-7 governments similarly stressed the importance of private sector participation in their meeting on the development of the Global Information Infrastructure (GII) in Brussels in February 1995. One concern that Asian and multinational firms in the communications industry had before the Seoul meeting was whether Asian countries, whose telecommunications industries are typically dominated by a state-owned monopoly carrier, would be willing to place similar emphasis on the private sector.

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In the Seoul Declaration, however, APEC members stressed their belief that "a greater business/private sector initiative and investment is vital for successfully implementing the APII." Among the ten core principles the Ministers established for the APII, principles number two and three are: promoting a competition-driven environment and encouraging business/private sector investment and participation.

This emphasis on the private sector demonstrates a willingness on behalf of Asia's leaders to appreciate that the private sector can bring new technology and greater competitiveness to information and telecommunication services. In the Seoul Declaration, the minsters recognized that the creation of an information infrastructure would be a vital tool in providing industries and firms throughout those countries the access to information they need to compete in the modern economy. In addition, they realized the development of the APII in itself would spur considerable job creation in fields such as software development. Already the job creation potential of the information superhighway can be seen, for example, in Beijing, whose flourishing software industry has received a healthy boost by the need to develop Chinese language software for communication on the Net.

V. THE FUTURE OF THE INTERNET IN ASIA

While the Internet has experienced exponential growth in Asia over the last two years, a number of major challenges remain if the Net is to reach its full potential in the region. The first and most obvious is the shortage in the developing countries of the region of the two indispensable elements of going on-line: a computer and a telephone line. While Japan, Hong Kong and Singapore may have teledensities that match their developed counterparts in the West, the number of telephones per 100 people in developing countries such as India, China and Indonesia still remains at less than 3. Computer access in these developing countries is even more restricted.

Nevertheless, Asia's developing countries have increasingly recognized the importance of telecommunications infrastructure and have launched an unprecedented expansion of their telephone networks. In China, for example, the Ministry of Posts and Telecommunications has announced an ambitious scheme to triple the number of the country's existing telephone lines to over a hundred million lines by the year 2000. Indonesia, Thailand, India and other less-developed countries have announced or commenced similarly ambitious plans. One encouraging sign for Internet growth is that the countries laying these millions of new lines are able to take advantage of the latest advances in wireline technology including fiber optics and the establishment of ISDN networks. Such high-capacity lines are vital if Internet users in these countries are to have access to Net features such as the World Wide Web that demand extra bandwidth.

A separate but related question is one that Internet service providers in the United States and throughout the world are facing: the question of capacity and pricing. With the great growth in the number of Internet users and even more importantly with the tremendous demand that the new World Wide Web features place on bandwidth, Asian countries will need to dramatically expand the capacity of their gateways, or information traffic jams along the Internet could become as severe as traffic congestion in Asia's major developing cities. To give an example of the demands the Web places on bandwidth, the same one million bytes that can capture the text of a 700-page book can only carry 50 spoken words or 3 seconds of video.

In order to meet these capacity constraints, service providers are debating the use of pricing schemes that take into account bandwidth usage in addition to or as a substitute for the current standard of on-line time. Critics of such proposals fear they will stifle Net use by individuals who are not able to pay premium prices and thereby limit the openness that has been so important to the Net's growth. Pricing schemes in Asia that essentially price out all but the most affluent business customers would discourage the browsers and individual users who give the Net much of its vitality and have brought many of its innovations.

The participation of the private sector service providers will be a critical factor in furthering competition and expanding the Internet's presence in Asia. While APEC ministers in Seoul strongly supported private sector participation in the APII, concrete actions have not yet matched the rhetoric of the Seoul Declaration. Nevertheless, it should be noted that Asian Governments in the last two years have begun to demonstrate a unprecedented openness to the participation of the private sector, including multinational firms, in the construction and operation of national telecommunications networks. Indonesia's Joint Operating Scheme and Thailand's partnership between NYNEX and TelecomAsia are two excellent examples. Even China, despite the stated long standing policy of monopoly in the operation of telecommunication networks, has established Liantong or Unicom, which is to construct a second network in China and which has actively been seeking foreign capital and technology.

For the Internet to flourish, countries must allow private service providers to compete for customers, as this competition will spur innovation and lower prices. The best example of a competitive Internet access market is Hong Kong, which currently has over 35 competing service providers. The competition among them, not surprisingly, has lowered prices and spurred new services.

In other countries, though, competition has not been as widespread. For example, in China, the Ministry of Posts and Telecommunications in April 1995 launched Chinanet, the country's first commercial Internet provider. The cost of Chinanet, however, is $70 a month for 40 hours of use, or approximately one month's salary for the average Chinese person. In Japan, frequent traffic tie-ups on the information superhighway are the result of NTT's failure to provide sufficient capacity to meet demand. And, in Vietnam, the state-run telephone company is attempting to close down alternative Internet providers on the ground that they encroach upon its monopoly position.

It is likely that entrenched monopoly carriers will continue to oppose competitive Internet services both because such services would encroach upon their monopoly positions and because they may see the Internet as threatening their highly profitable IDD and fax services. Until state-run monopolies begin to loosen their grip on Internet service, it will remain out of reach for most citizens of Asia's poorer nations.

There are other obstacles which threaten to stunt the future growth of the Internet in Asian countries. From local academics' recent protests over the availability of cyber-porn to university students in Hong Kong to the Chinese Government's fears that access to the Internet would allow its citizens access to information otherwise not available to them, a number of Asian countries have grappled with the problems arising from the wide-open and unrestricted flow of information coursing through the Internet. A spate of stories in the press over recent months has detailed how certain Asian governments that are normally quite protective in regards to allowing information from outside to be brought into that country have wrestled with the question of whether and how to censor on-line information.

No government has yet resolved the dilemma of how to take advantage of the economic opportunities on the Net without exposing large segments of their population to politically tumultuous ideas. The Asian governments are concerned that speech which would be banned on the grounds that it was politically sensitive, religiously blasphemous, or culturally offensive will now be available instantaneously to Internet users throughout their country. Compounding the problem is the fact that these Asian governments have suspicions about the Net as essentially an American system and one that had its beginnings in the U.S. Department of Defense during the Cold War. While Internet users may appreciate the fact that the system's complexity and the absence of a single central hub makes censorship extremely difficult, this is the same fact that gives the regimes cause for concern. It is already evident that the openness that makes the Internet so useful will stir more than its share of controversy in Asia, and perhaps slow access to the Net in certain countries.

It should be stressed, however, that the lack of control over the information that is stored and transmitted over the Internet is a concern not solely of a conservative Asian governments but rather a concern of Net users and governments worldwide. For example, in the United States the question of pornography transmitted over the Internet has generated considerable debate and concern in Congress. Indeed, the telecommunications bill passed in June by the Senate contains a provision criminalizing the transmission of any obscene, nude or indecent content over the Internet. It will be interesting to see if governments in Asia enact similar criminal statutes and, if so, the scope of such statutes and the manner in which they seek to exercise jurisdiction over those transmitting information in violation of the statutes.

The flip side of the question of governments attempting to suppress information that individuals put on-line is the question of how individuals can ensure control over the privacy of their on-line communications. Some users fear that the consequence of gaining access to information is that the government, in a big-brother-like fashion, will be able to gather even more information on them. These fears of compromised privacy were exacerbated earlier this year in Singapore and Hong Kong when the two governments, for different reasons, launched raids on Internet service providers and took into custody users' e-mail files.

VI. CONCLUSION

In sum, the Internet offers tremendous promise for Asia: promise for access to information, cutting costs, providing new jobs, spurring economic growth and developing cross-cultural understanding. At the same time, the growth of the Internet will be very much dependent on the wider telecommunications infrastructure revolution that is now taking place in Asia and, in particular, on the steps taken by countries in the region to privatize and allow competition in their telecommunications services sector. On a broader level, the future of the Internet will depend on the degree to which the features that make it so attractive -- its egalitarianism, its openness and its accessibility to all persons and all ideas -- prove to be its strength or its undoing.

THE INTERNET & CYBERSPACE REVOLUTION:

IMPLICATIONS FOR DEVELOPING AND DEVELOPED COUNTRIES

by

Michael Potter
President, Esprit Telecom
Amsterdam, The Netherlands

Abstract

This paper provides an overview of the lessons learned from the development of the Internet and its implications for telecommunications in developing and developed countries. The paper explores the challenges that these lessons pose for the telecommunications industry.

I. Introduction

It is estimated that there are approximately 35 million users of the Internet. While this is an impressive number, the dramatic point that the Internet has made, is the speed at which these millions of users became "wired" into this global network. The emergence of the Internet and cyberspace fundamentally challenges orthodox approaches to the development of telecommunications.

In the past, telecommunications has been the domain of centralized monopoly telecommunications operators. The Internet is the product of decentralized, non-monopoly players and users. In fact, it is argued that the Internet should be viewed as "organic" almost biological in its development. This development is in sharp contrast, for example, to France Telecom's Minitel which originated from a traditional hierarchical business development model. The widespread development of the Internet brings into question telecommunications modernization in developing countries and the effectiveness of currently structured monopoly and dominant phone companies in industrialized countries.

There are macro-economic implications resulting from the Internet and the cyberspace revolution. This revolution is a revolution in technology, and more importantly a conceptual revolution. First, there are profound implications for the rapidly accelerating gap between many of the developing countries and developed countries. Second, I believe there will be unexpected winners and losers. For example, relatively developed economies in Europe may fall behind emerging economies in Asia as a result of these profound changes. Economic drivers will shift from atoms to digits (which describes the transition from an industrial economy to an information economy) which will potentially shift wealth generation of entire nations.

II. The Case for Telecommunications Modernization in Developing Countries

There is no question that the Internet has been hyped beyond any concrete reality. (Simply look at the remarkable valuation attached to the Initial Public Offering (IPO) of Netscape, the provider of an Internet browser.) If nothing else, Internet should simply raise the larger questions related to accessing and utilizing cyberspace. The Internet immediately raises questions regarding another overly hyped and misunderstood concept, the "information superhighway." The information superhighway, I believe, provides an excellent metaphor for understanding the importance of the basic framework necessary for accessing cyberspace. An individual or a country cannot reasonably participate in the cyberspace revolution unless they can have the following available to them at low cost:

1. Origination: Access to the superhighway
2. Transportation: Access along the superhighway
3. Termination: Exit from the superhighway

Most telecommunications professionals do not question the need for rapid modernization of telecommunications in developing countries. So perhaps it is a luxury that in the UK a debate has been sparked over the development of the information superhighway. Dr. John Habgood the Archbishop of York has challenged the government's technological and policy oriented imperatives aimed at creating the development of an information superhighway. According to Archbishop Habgood:

> "My nightmare of society is a lot of self-centered individuals concerned only with their own self-fulfillment, sitting all day in front of their computers or television screens and soaking their minds in increasingly violent or obscene entertainment, doing their shopping by tapping on a keyboard with no need at all to come to terms with other people or learn to relate to them, which is how we grow as human beings."[i]

These "moral" and "spiritual" concerns combined with topics such as "cultural imperialism," and "technological dependence" are not likely to evaporate in our life times. Dr. Joseph Pelton recently wrote of the dramatic change that is taking place in the cyberspace industry.

> "These days it seems hard to shop at a grocery store, check out a library book, or even flush a "smart toilet" without having a close encounter with cyberspace. The combination of information systems, computer operations and telecommunications has nosed out transportation, energy, or agriculture as the world's largest industry. One out of every 15 dollars spent on this planet is invested in some element of cyberspace. We are rapidly moving toward an environment where we can connect with anybody else anytime and anywhere or access a prodigious amount of information. Since the time of Ancient Greece, our global population has increased a remarkable 50 times. During the same period of time, our global information base has increased an even more remarkable 10 million times. This is to say the information in cyberspace is expanding some 200,000 times faster than humanity itself. This is not like a man chasing a Ferrari, but rather more like a turtle chasing a space ship."[ii]

Many arguments can be made to justify the acceleration of the information superhighway in developing countries. It is my belief that we ought to work hard to close the rapidly increasing information gap which may be a moral imperative. We should not, however, waste time getting a consensus to resolve the moral issues that may simply be the equivalent of asking, "how many angels can dance on the end of a fiber optic cable?" One of the reasons is that people who are not plugged into cyberspace cannot take part in this debate.

Access to cyberspace is not an option for those countries and individuals that want to participate in a meaningful way in the information economy -- it is a precondition.

Generally it can be argued that most developed economies have now moved from agrarian to industrial, to digitally based economies. Interestingly, today even agriculture and industrial enterprises rely heavily on information technology. Many Asian countries have moved in a shorter period of time from agrarian to industrial and even digital economies than their European counterparts. In fact, many Asian countries absorb new technology faster then some European countries. I believe that if the countries of Europe do not demonstrate strong leadership in this area, they will be left technically behind the Newly Industrializing Countries of Asia.

III. The Development of Internet: Lessons for Modernizing Telecommunications

The traditional approach to modernizing telecommunications in developing countries is to focus on the activities of monopoly telephone operators. I believe that this is a fundamental mistake. The World Bank and other developmental banks and organizations should demand a very high level of proof that any investment in a country will get the biggest bang for the buck. Funding should not be provided to monopoly operators unless they meet a very high threshold of proof that they are best able to perform and generate the desired results. The monopoly operators certainly do not have a reputation for technical innovation, nor efficiency. Increasingly, the telecommunications industry is beginning to resemble the computer industry and vice-a-versa. I believe that resources should be provided to alternative non-monopoly providers in many developing countries. If governments do not like competition, the highest level of diplomatic and commercial pressures should be used to open these markets.

Many monopoly operators have been around for nearly 100 years and have completely failed at providing reasonable access to telecommunications services. Moreover, monopoly providers tend to be threatened by (and successfully stop) innovations that they perceive as jeopardizing their existing revenue base. Simply look at call back services, VSATs (Very Small Aperture Terminals) or voice over Internet for a few examples of unwelcome service offerings.

The success of the Internet has been largely the result of its decentralized and low cost development. Because of its store-and-forward electronic mail capability, Internet can provide an excellent telecommunications tool for developing countries. Developing countries can use a variety of store-and-forward technologies including enhanced fax and voice mail to overcome current infrastructure shortages.

By utilizing electronic mail (even through the Internet itself), entire organizations are undergoing profound change. In the past, the management structures of monopoly telephone companies resembled traditional hierarchical (military style) organizations. Monopoly phone companies are no longer models for running phone companies or any other efficient business. Managing knowledge workers who operate in "virtual offices" requires a fundamental departure from previous management and organizational techniques. Providing developing countries with telecommunications capabilities requires efficient investment of limited resources and the rapid implementation of innovative ideas.

IV. Conclusion

In order to speak in a meaningful conceptual fashion about the Internet, it should be seen as a metaphor for the cyberspace revolution. The development of the Internet itself provides some interesting lessons for comparing and contrasting the attributes that have led to innovation and efficiency in the computer industry, and those that have slowed innovation and efficiency in the telecommunications industry. I believe it should be one of the highest rational and moral obligations to accelerate access in developing countries to the cyberspace revolution. Developed countries should focus on creating the preconditions for sustaining the cyberspace revolution, not suppressing developing countries' pursuit of excellence in the cyberspace revolution.

References

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[i] Viewpoint, "We Need a Devil of a Debate on Superhighway," Evening Standard, August 9, 1995, p.32.

[ii] Pelton, Joseph, Editorial, "Re-inventing Cyberspace: Advanced Satellites and the Global Information Infrastructure (GII), Space Communications: an International Journal, Volume 12, Numbers 3,4 (1994) pg. 119.

THE INTERNET GOES INTERNATIONAL: INTELLECTUAL PROPERTY CONSIDERATIONS FOR INDUSTRY

by Phillip L. Spector
Partner, Paul, Weiss, Rifkind, Wharton & Garrison
Washington, D.C.[*]

Just as the Internet relies on a "network of networks," the protection of intellectual property internationally relies on a "system of systems." Copyrights, for example, are protected by disparate national legal regimes, with the protections woven together through several international treaties. Harmonization of national copyright enforcement regimes is essential with respect to digital communications. This paper discusses various national initiatives to contend with the challenges that the Internet poses to the protection of economic and moral rights in original works, and points out that harmonization is difficult because of divergent notions of copyright globally.

The Internet has created rich opportunities for companies to provide a wide variety of new products and services; on-line financial transactions, software, educational services, media entertainment, and video games either are, or will soon be, widely available on the 'Net. Because digital technology allows the making of perfect electronic copies, however, the Internet has also created rich, indeed unprecedented, opportunities for the theft of intellectual property.

The global reach of the Internet leaves the owners of electronic property vulnerable to violations of intellectual property rights in any "networked" corner of the world. The thesis of my speech is that, as the Internet becomes increasingly internationalized, the on-line services industry and the companies that provide content to the networks must be "pro-active" in developing ways to protect intellectual property made available on-line.

I will begin by describing the current structure of the Internet and explaining why this technology is susceptible to wide-scale international piracy. Then, I will discuss U.S. and international legal protection for intellectual property rights, in particular focusing on copyright protection, and describe how gaps in the current legal framework make it inadequate to combat piracy on the Internet. Finally, I will suggest some steps that content providers and on-line services can take to minimize the losses from such piracy.

I. TECHNOLOGICAL AND COMMERCIAL CONSIDERATIONS GOVERNING THE GROWTH OF THE INTERNET.

Growth, use, and globalization of the Internet.

The Internet is a loose affiliation of interconnected computer networks that has been in existence for 25 years. The Internet developed as a method of connecting different computer networks to each other,(1) so that computer scientists and other military technicians in the Cold War era could exchange information. Academic institutions joined this affiliation of interconnected networks early on, followed by local area networks in the work place and, finally, at-home users of personal computers.

Access to the Internet is provided currently through Internet Service Providers ("ISP") and on-line services. Larger organizations, such as businesses and universities, tend to contract with ISPs on a capacity basis(2) for access to the Internet. Today, there are nearly 600 carriers on the Internet, most of which are start-up companies such as Performance Systems International, Netcom, Pipeline, UUNet, Demon and Pipex.

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Most individuals who use the Internet at home access it through a commercial on-line connection service, such as Compuserve, America On-Line, or Prodigy. They usually pay a monthly fee of $10-20, which typically provides an unlimited amount of time on-line and does not distinguish between communications within the neighborhood and communications overseas.

Currently, there are more than 20 million Internet users worldwide, including over 80,000 businesses. The typical Internet user today relies on the 'Net to transmit electronic mail and to download and upload information from "electronic bulletin boards," which are clearinghouses of information on a variety of different topics.

From its base in the U.S., the Internet has grown increasingly international. Currently, 70 percent of Internet "host" computers are located in North America, 21 percent are in Europe, seven percent in Asia, and the remainder in other parts of the world. Internet usage in North America is growing at a staggering 100 percent annually, in Europe at 88 percent, and Asia 87 percent. During the past year, the number of new hosts grew by 116 percent in Central and South America, and by nearly 150 percent in Africa.

The increasing commercialization of the Internet.

On-line service providers are scrambling to develop systems for generating and collecting revenues on the Internet, by facilitating Internet access and making high quality content available on-line. A recent survey estimated that sales of products and services over the Internet between August 1994 and September 1995 will reach $118 million.(3) Those who stand to gain from the creation of this new market are creators of original works, publishers, on-line services, carriers, advertisers and end-users.
Three factors are driving the growth of commercial offerings on the Internet:

- Loss of subsidy. The U.S. government is phasing out its National Science Foundation subsidies to the system, which the Internet has traditionally relied on to fund the operation of its backbone network. With the subsidies gone, private companies have stepped up to the task of maintaining this backbone.

- Distribution channel. On-line providers will increasingly seek to market their services by providing higher value-added content and a high degree of customer service and specialization. On-line service providers will serve increasingly as distribution channels for content, negotiating with content providers and monitoring the content available on-line.

- Marketing to the consumer. As the breadth of information available on-line expands, however, tools for navigating through the information will become increasingly important. The "gateway" services of on-line providers will play a major role in shaping the future of the Internet by collecting information, organizing it, and making it available to customers in a useful format. According to industry analysts, these gateways could see revenues of up to $13 billion in the year 2000.

The Prospect of International Electronic Piracy.

With a growing network of users all over the world, the Internet provides ripe opportunities for transmitting illegally acquired content. In the past, pirated copies of text, and of audio and video tapes, suffered from reduced quality. This put a limitation on the number of generations of copies which could be made from an original; each copy reflected a progressive deterioration in quality. With digitization, pirated copies no longer bear the tell-tale signs of piracy; each copy is now as good as the original.(4)
Because there are no national boundaries dividing up the different networks within the Internet, any person, in any country, can "upload" digital information to an electronic bulletin board from which thousands of users all over the world can make copies. Often, the source of the material is untraceable. This means that the efforts of certain content providers purposely to avoid or delay distribution of "hard copies" of movies or sound recordings to particular markets for fear of piracy may be undermined. International distribution of materials over the Internet may occur in the time it takes to place an international telephone call.

If past is indeed prologue, there is good reason to fear that an internationalized Internet that provides access to high value-added content may become a

618

haven for electronic pirates. Even without wide-scale availability of on-line content, international piracy of U.S. copyrighted works has had a significant economic impact on United States.(5) U.S. government sources have conservatively estimated annual losses in the range of $12-15 billion,(6) while industry estimates are even higher. Now consider the Internet, a network providing worldwide access to proprietary material, where digital piracy can be accomplished by the click of a mouse.

Even though the prospects for international piracy on the Internet appear great, computer technology seems to have outstripped the legal tools available to combat piracy. Gaps in U.S. and international copyright laws may have rendered them ineffective to prevent widespread piracy on a global network of networks.

II. LEGAL PROTECTION OF COPYRIGHTED MATERIALS ON THE INTERNET

Protection of Copyright in the United States

The United States Copyright Act was designed to strike a balance between the interests of authors and society's competing interest in the free flow of ideas, information, and commerce. Copyright law protects an author's expression once it has been fixed in a tangible form. Copyright protects literary and musical works and lyrics, artistic performances, pictorial, graphic and sculptural works, motion pictures and other audio-visual works, and sound recordings. Computer programs are considered to be literary works for the purposes of copyright protection.

A copyright provides its owner with a bundle of rights in the protected work, including the rights to distribution, reproduction, performance, adaptation and display. The copyright law prevents unauthorized copying of a protected work.

The rise of computer networks have posed major challenges to conventional concepts of copyright protection and enforcement. To begin with, the owners of copyrighted materials must contend with the reality that the law as currently written may not anticipate certain kinds of infringement that computer networks, including the Internet, have made possible. In addition, the providers of on-line services and computer bulletin board operators must be aware that, in response to perceived abuses on computer networks, potential liabilities for infringement have broadened and may include not only the actual infringer, but entities that make access to the network or the bulletin board possible.

Protection for content providers. The Information Infrastructure Task Force (IITF), a group formed within the Commerce Department in 1993 to coordinate public-private cooperation in the development of a National Information Infrastructure ("NII"), recently issued a report discussing legal ambiguities in U.S. copyright laws as applied to computer transmissions.(7) These ambiguities directly affect content providers and may cause many of them to forego the opportunity to go "on-line" for fear of electronic theft.

- Transmission of Data. Copyrighted material is protected from being "distributed, reproduced, performed, or adapted" without permission from the copyright holder. Because digital data is materially different from printed matter, there is some debate over whether an unauthorized computer transmission of a protected work violates these rights.(8)

- "Fair Use". The bundle of rights guaranteed by U.S. copyright law is limited by the doctrine of "fair use". Under this doctrine, reproduction of a work for such purposes as criticism, comment, news reporting, teaching, scholarship or research is considered "fair use" and is not deemed to violate a copyright holder's rights.(9) The IITF Working Group has suggested that specific library and educational applications on the Internet should be included in the copyright law as "fair use." On-line access to educational and library facilities is, indeed, a bedrock objective of the NII initiative. If the definition of "fair use" becomes too broad, however, copyright holders may lose their ability to sue for the widespread downloading of "library materials" over the Internet.

- First Sale Doctrine. The "first sale" doctrine also limits the copyright owner's "bundle of rights," by providing the buyer of a copyrighted product with almost complete discretion over the physical copy purchased. The buyer may sell, rent, or give away the volume without infringing the copyright. The copyright statute contains exceptions to this "first sale" limitation for phono-recordings and computer programs, because of the ease of making a home copy and passing along the original.

While computer programs are exempted from the first sale exception to copyright, the exception still applies to sales of copies of digitized audio recording, movies and other new media that may be transmitted on-line. As new media become available in digital format, the exemption from the first sale doctrine must be broadened to cover ALL digital transmissions.

Liability of gateway service providers and bulletin board operators. Once a copyright violation has been uncovered, liability for the infringement must be determined. Because it is virtually impossible to determine who actually uploaded the infringing material, many copyright holders have attempted to hold on-line service providers liable for on-line infringement.

Carriers and gateway services, legitimately concerned about their inability to monitor the content flowing through their wires, argue that they are mere conduits for information and not directly or indirectly responsible for actions by their subscribers. Operators of electronic bulletin board services, who are expected to have some editorial discretion over the content on the bulletin board, have more difficulty making this argument.

At this point, U.S. case law is still ambiguous regarding the circumstances under which an on-line service provider can be held liable for the actions of its users.

- In 1991, Compuserve, the largest on-line service, was sued for defamation based on allegedly libelous statements contained in an electronic newsletter.(10) Compuserve had contracted with a separate company to edit and monitor the forum. Under New York libel law, one who republishes defamatory matter is liable for defamation. However, because of the public interest in preserving access to information, news vendors, book stores and libraries are not held liable unless they knew of, or had reason to know of, the defamation. In this case, the New York district court held that Compuserve was not liable since it resembled a public library or newsstand more than a publisher, and could not be expected to monitor all of the content which it carried.

- In 1993, Playboy sued George Frena, an operator of a computer bulletin board service that served as a means for subscribers to download and upload copyrighted photographs from Playboy and Playgirl magazines.(11) The files containing the photographs were labeled with the Playboy and Playmate trademark names. Frena denied that he had performed the copying himself and tried to claim that the usage of the photographs was insignificant and therefore, a "fair use."

  The court found that Frena had directly infringed on Playboy Enterprises' copyright by violating its right to distribution and its right to display. It determined, that, because the usage had been commercial in nature, the material was protected, the copying was qualitatively substantial, and widespread copying would impact the market for the material, Frena could not defend himself by claiming "fair use."

- In 1994, Sega Enterprises sued the MAPHIA computer bulletin board service, which was being used by subscribers to exchange copies of Sega's copyrighted computer video game programs.(12) Although the defendants did not actually perform the copying, they advertised the availability of Sega games on the service, provided equipment specifically designed to facilitate copying, and charged a fee for downloading.
  The court found that, although the bulletin board operators did not know exactly when the infringing material was being uploaded or downloaded, "their role in the copying, including provision of facilities, direction, knowledge and encouragement, amount[ed] to contributory copyright infringement." The court supported a preliminary injunction and issued a seizure order under which the defendant's computer and memory devices were seized and copies of the infringing material were erased.

- Last May, a New York state court distinguished Prodigy from other on-line services, finding it liable for statements accusing a brokerage house of stock fraud which a subscriber had posted to an electronic bulletin board service. The judge stated that Prodigy was in a unique position in the on-line services industry because it had advertised control over the content on its service, holding itself out as a family-oriented computer network. He rejected Prodigy's claim that it could not monitor the 60,000 messages on bulletin boards, pointing out that Prodigy employed board monitors and had screening software. The fact that Prodigy held itself out as a service that exercised control over content appeared to be the determinative factor in this ruling.

International Protection of Intellectual Property

While the United States is experiencing growing pains from the domestic expansion of on-line capability, it is also becoming aware of the potential threat from expanded international access to the network. A significant number of persons in the developing world feel that there is a "public right" to intellectual property. Efforts by industrialized countries to enforce these rights, according to this view, are an attempt to preserve pre-existing monopolies at the expense of developing country consumers.

The legal tools available to an infringed U.S. copyright owner are wholly inadequate to deal with international electronic piracy. To begin with, even if jurisdiction over an overseas infringer could be obtained, acts of infringement that occur outside the jurisdiction of the U.S. are not actionable under the U.S. Copyright Act. This suggests that the U.S. gateway providers or bulletin board operators that permit access to unauthorized copies of protected works from overseas sources may be the only available defendants, although their liability may be questionable.

International copyright law also appears to be unequipped for the advent of an internationalized Internet. Currently, copyright protection in the international arena is governed by the Berne Convention and administered by the United Nations' World Intellectual Property Organization ("WIPO").(13) The Berne Convention's guiding principle is "national treatment," a requirement that each nation provide the same degree of protection to other nations that it provides to its own citizens. Potentially, this means that the best international copyright protection in the age of the Internet will the lowest common denominator of the country with the weakest intellectual property regime and telephone access to a computer network.

In fairness, however, the Berne Convention specifies certain minimum protection which must be accorded by all nations to copyright holders. Authors receive protection for life plus fifty years. Computer programs are considered literary works. The copying and storage of works in computer systems, as well as the copying of works from other media into digital form, is considered to be a reproduction or copy of the work. This encompasses uploading as well as downloading of material.

Despite these provisions, the Berne Convention has been criticized for having few substantive restrictions and for having weak compliance and dispute resolution mechanisms. The Convention contains two, non-mandatory, provisions for seizure of infringing materials as its only method of enforcement.

U.S. frustration with the ineffectiveness of protection under the Berne Convention has led it at times to rely on bilateral agreements, and even unilateral actions such as sanctions under Section 301 of the 1988 Trade Act or the withholding of preferences under the Generalized System of Preferences ("GSP") -- to protect U.S. copyright holders. For example, in 1989, the U.S. withdrew GSP treatment for 15 products from Thailand as a response to widespread piracy of software and music recordings which caused about $175 million in annual losses to American software companies. The GSP treatment, a benefit to Thailand of about $807 million, was reinstated after Thailand rewrote its copyright law and created a special intellectual property department within the Ministry of Commerce to train police and judges in copyright enforcement.

During the Uruguay Round of the GATT negotiations, dissatisfaction with the inadequacy of multilateral measures for copyright protection resulted in a special Agreement on Trade Related Aspects of Intellectual Property Rights ("TRIPS") to establish intellectual property right obligations for members of the new World Trade Organization. Under the TRIPs agreement, all members of the WTO are required to follow the substantive obligations of the Berne Convention. Because the TRIPS agreement accompanies the GATT trade agreement, the protections it provides are bolstered by the mechanisms for enforcement and dispute resolution that resulted from the Uruguay Round. It is an important move toward increased protection and global harmonization of intellectual property rights. However, because its provisions allow a twelve year phase-in period for developing countries, it offers limited short-term relief from piracy of intellectual property.

III. STRATEGIES FOR COPING WITH PIRACY ON AN INTERNATIONAL INTERNET

How can the prospect of international piracy of commercial content on the Internet be mitigated? I believe that content providers and on-line services cannot afford to wait for government to solve their problems or for legal structures to catch up with the reality of the marketplace. They will have to engage in self-help in order to protect themselves from theft of intellectual property or liability for it. I have several suggestions that may be useful in this regard.

First of all, copyright owners need to acknowledge that piracy on the Internet will take place. Withholding content from the system may not work; as long as it is available somewhere in the world, anyone may upload it illegally. Content providers may have no choice but to rethink the way that on-line deals are made and to develop innovative ways of maximizing revenues.

One possible strategy that content providers can use is to build the cost of potential piracy into the fees they charge to on-line service providers. The costs of providing higher quality content could be incorporated into the subscriber fee charged by on-line services, as is done in the cable television industry. The subscriber fee in turn would build in an estimated cost of piracy.

A corollary to this strategy assumes that, as the Internet grows, advertising could become an increasingly important source of revenue for both content providers and on-line services. If this occurs, content providers could draw lessons from the radio industry and its complex formula for determining revenues to artists based on air time.

Another variation on this theme calls for content providers to take an equity position in, or to start their own, on-line services. Content providers would in effect become gate keepers, and would be better able to adjust rents on the system to respond to licit and illicit usage.

For their part, on-line services can mitigate their potential liability by promoting self-monitoring of the Internet. For example, they can make all subscribers, particularly independent moderators of bulletin board groups, aware of their intellectual property obligations by posting notices and warnings throughout the system and in subscription agreements. The on-line services are in the best position to promote a culture which preserves intellectual property rights.

In the same vein, on-line services can provide encryption services concurrently with the provision of expensive content, and contractual provisions with the on-line services industry should specify the use of such technology. Encryption works in much the same way in which "scrambling" works to prevent unauthorized reception of cable TV signals. Of course, parallel technologies, designed to circumvent such barriers to access, are developing just as quickly. The IITF draft suggests amending the Copyright Act to prohibit the manufacture, sale, or distribution of devices designed to bypass or deactivate legitimate protective technology. Members of the Committee of Experts on a Possible Protocol to the Berne Convention have made similar suggestions.

Finally, although it may seem counterintuitive, U.S. companies should also encourage the growth of legitimate "content" industries overseas. American industries can provide technical expertise as well as start-up capital to these industries so that they assist in fulfilling domestic demand. Countries which have developed their own film-making and recording industries, such as Japan and India, have seen an increasing respect for intellectual property rights. When these rights become important for domestic industries, the industries begin to pressure their governments for enhanced legislation and enforcement of intellectual property rights.

While the solutions discussed above are unlikely to resolve all of the intellectual property problems associated with internationalization of the Internet, they will allow content providers and on-line services to mitigate the most egregious ones. While their interests diverge at some level, both content providers and on-line services have in interest in making the Internet safe for intellectual property and ripe for commercial development.

ENDNOTES

1. Information on the Internet is split up into tiny packets of digital data which are dispersed over existing telephone cables by a "server" computer. A computer known as a "router" selects the most efficient path of transmission through the web of networks and propels the packets forward; they are reassembled into cogent messages at the point of reception.

2. ISPs generally lease the lines which they use to connect to an Internet server.

3. Kate Maddox, Internet Commerce on the Rise, Interactive Age, July 3, 1995, at 31, citing survey by ActivMedia.

4. It is nearly impossible for a gateway service to determine pirated content from an analysis of the signals transmitted over the Internet.

5. Industries that rely on copyright protection comprise about five percent of the United States gross domestic product, and employ about four percent of our labor force. NII Group Recommends 'Modest' Copyright Law Changes, Telecommunications Reports, July 11, 1994 at 30.

6. Information Infrastructure Task Force, Intellectual Property and the National Information Infrastructure: A Preliminary Draft of the Report of the Working Group on Intellectual Property Rights, July 1994.

7. ("IITF Draft"), p.81.

8. The IITF Working Group agreed with the publishing industry that transmission is equivalent to distribution, although it suggests that there is a difference between transmissions that are communications of performances or displays and those that are distributions of reproductions.

9. In order to determine whether a particular use of protected material constitutes "fair use", courts consider (i) the purpose and character of the usage and whether it is commercial or non-profit, (ii) the nature of the copyrighted work, (iii) the amount and substantiality of the portion used in relation to the whole, and (iv) the effect of the use on the potential market for, or value of, the copyrighted work.

10. Cubby v. CompuServe, 776 F.Supp. 135 (S.D.N.Y. 1991)

11. Playboy Enterprises, Inc. v. Frena, 839 F.Supp. 1552 (M.D. Fla. 1993)

12. Sega Enterprises Ltd. v. MAPHIA, 1994 U.S. Dist.LEXIS 5266 (N.D.Cal. March 28, 1994)

13. Although the Berne Convention was initiated in 1886, the United States did not become a signatory until 1989. Material published before that time in the United States is likely to be subject to the less rigorous provisions of the 1952 Universal Copyright Convention (UCC).

Telecommunication in Slovak Education: A PSSC Legacy Project Helping Build Economy and Democracy in Slovakia

J. H. Southworth, University of Hawai`i
Curriculum Research and Development Group
University of Hawai`i
Honolulu, Hawai`i, USA

and

Jozef Hvorecky, University of Economics
Bratislava, Slovakia

1. ABSTRACT

The Telecommunication in Slovak Business and Economics Education Project (TSE) was made possible by the Legacy Fund of the former Public Service Satellite Consortium (PSSC) that seeks to promote telecommunications awareness and training within educational and community groups and in developing countries. TSE was oriented to the training of university lecturers, researchers and high school teachers in the use of telecommunications in education (with the stress on the use of computer networks and remote databases).

This project has demonstrated the potential for not only building telecommunications awareness and skills but international understanding and strengthening of democracy in a newly-independent country.

1.0 BACKGROUND

1.1. HISTORICAL OVERVIEW

Slovakia is facing a new challenge after years of Communist separation and eventual opening of its society to the market economy and free enterprise. It partially means the rebuilding of its educational system and its reformation to a democratic society. These changes can be accomplished in various ways:

a) Activating its internal educational infrastructure and

b) Utilizing international cooperative experiences.

The first alternative involves rennovation of curricula, retraining of teachers, and replacing old methodologies with new ones. That is a very difficult process because any educational change takes a long time. On the other hand, studying educational systems from abroad and selecting those appropriate to the local needs can accelerate the process.

The latter method has been extensively used in the collaborative effort between the Slovak Ministry of Education, State Institute of Pedagogy (Bratislava), University of Economics in Bratislava, the United States Peace Corps in Slovakia and the University of Hawai`i Curriculum Research & Development Group (CRDG).

1.2 *FAST* (FOUNDATIONAL APPROACHES IN SCIENCE TEACHING)

The Telecommunication in Slovak Business and Economics Education project grew out of an innovative partnership between Hawai`i and Slovakia to promote middle school science education. The Foundational Approaches in Science Teaching (***FAST***) is a three-year, integrated, hands-on, environmentally-focused middle school science program developed by the University of Hawai`i Curriculum Research & Development Group (CRDG).

The co-authors originally met in Moscow in April 1992 when the concept of the Eastern Europe ***FAST*** translation projects was developed. They and their colleagues have worked ever since on details of translation, printing and copying, teacher training, pilot testing, trainer certification, evaluation, and funding searches for using ***FAST*** in Russia and Slovakia.

At this time, there exist seven pilot schools with ***FAST***-trained Slovak science teachers assisted by Peace Corps Volunteer English teachers serving as "***FAST*** Mentors." The schools are all connected by computer network to the international Internet system.

The Slovakia program has involved since 1992:

- Translation of ***FAST*** 1, 2, and 3 student texts,
- Training of Slovak middle school science teachers in ***FAST*** 1, 2, and 3,
- Certification of selected Slovak ***FAST*** teachers to become official trainers,
- Local training run by the Slovak ***FAST*** trainers of ***FAST*** 1 and 2, and
- Cooperation of the ***FAST*** in Slovakia program with U.S. Peace Corps Volunteers teaching English in Slovakia and serving as language mentors for some of the Slovak ***FAST*** teachers.

1.3 SANET (SLOVAK ACADEMIC NETWORK)

SANET was organized in 1991 with the first SANET node being located in Banska Bystrica connected to Internet via a 14.4 kbps line. By midyear 1995 SANET had grown to more than 400 members representing academic, research, scientific, governmental, non-project and commercial organizations. Two international lines connect SANET to the Czech Republic (Prague) and Austria (Vienna) with eleven local lines within Slovakia. SANET users have Internet services of email, telnet, ftp, World Wide Web, Gopher, Usenet News, X500, and Netfind servers.

SANET is funded by the Slovak Ministry of Education as a non-profit organization. All schools and organizations which are funded by the Ministry of Education have free use of SANET and only pay the telephone charge to the nearest SANET node. (Weis and Krajnak, 1995)

1.4 HI-NEST (HAWAI`I NETWORK FOR EDUCATION IN SCIENCE AND TECHNOLOGY)

Despite limited financial support for the projects in Eastern Europe, steady progress has been possible mainly due to reliable computer communication links, especially for desk-top publishing and regular electronic mail.

The HI-NEST model for this communication includes not only administrative email as mentioned but four basic types of program-related communication:

Student Communication System
- Collecting and sharing environmental data

Teacher Communication System
- Sharing of information and teaching strategies

Trainer Communication System
- Coordinating teacher training institutes

FAST Communication System
- Providing access to CRDG program information

Participation in HI-NEST was limited due to problems related to hardware, software, networking, and training. As networking advances (especially in terms of SANET access to Internet) more hardware and software connections were established. TSE was conceived as a way to help meet the lack of Internet awareness, understanding, and use by establishing a formalized training program.

1.5 PSSC AND LEGACY FUND

The Public Service Satellite Consortium (PSSC) was an important organization functioning mostly in the 1980's to promote and make possible use of new satellite services in the period when satellite user-costs were expensive. PSSC was able to assist its member organizations in paying lower rates by block purchases of satellite services in larger, more economical units and resell them to PSSC members. As satellite useage costs dropped PSSC services were no longer needed. It was decided to disband and transfer remaining assets to the PSSC Legacy Fund to support small telecommunications endeavors by groups dealing with educational and community service programs as well as in developing countries.

The availability of PSSC Legacy funding served an important role in providing basic telecommunications training of not only Slovak middle school ***FAST*** teachers but also computer resource teachers at their schools around Slovakia and faculty, students and staff of the University of Economics in Bratislava. A total of $8500 was granted TSE. The project took place during the calendar year 1995. The Legacy Funding was developed in cooperation with the San Diego State University Foundation.

2.0 TSE (TELECOMMUNICATION IN SLOVAK BUSINESS AND ECONOMICS EDUCATION PROJECT)

2.1 ORGANIZATION

The TSE grant was formally awarded by the Legacy Fund of PSSC to the University of Economics in Bratislava with Hvorecky as Project Director. Southworth was designated as Project Trainer and support for his travel and other expenses were channeled through the University of Hawai`i Foundation's Project Telecom 21.

It took about four months to get full agreement on all sides regarding project responsibility and fiscal procedures. Once that period was over plans moved smoothly.

2.2 PLANNING AND MATERIALS DEVELOPMENT

The TSE grant was announced in August 1994 just as Southworth was headed to Slovakia to assist in the ***FAST*** 1 and 2 training institutes in Bratislava. This provided a very helpful head start in making preliminary contacts with appropriate university officials and to make technical arrangements. Included in the latter was establishment of email accounts in Bratislava and Honolulu. These were accessible via telnet and allowed for pre-workshop testing and documentation development.

Discussion also was completed on plans for a manual covering the following outline:

- Introduction and Background
- Definitions of Synchronous and Asynchronous Communication
- Descriptions of Synchronous and Asynchronous Systems
- Introduction to UNIX Computer Basics
- Documentation on use of videophone, email, ftp, telnet, gopher, WAIS and World Wide Web

Subsequent production of the manual took place from November to January via email exchange of drafts. Initial writing in Slovak and basic translation in English was generally by Hvorecky with editing of the English version by Southworth. Final desk-top publishing in Bratislava resulted in a 67-page manual being ready for use at the February workshop.

2.3 FEBRUARY 14-17, 1995 WORKSHOP

Preparations were made for 20-30 participants. By the time the workshop started over 50 persons had signed up. This included 10 secondary school participants

(***FAST*** and computer teachers) and the remainder being university faculty, staff, and students. The University of Economics in Bratislava computer staff provided temporary accounts for participants who didn't already have their own accounts.

Because of the larger-than-expected number of participants, the workshop hands-on sessions were divided into two parts (Groups A and B). Most lectures and lab sessions were held at the facilities of the Faculty of Informatics, University of Economics in Bratislava. Daily schedules included normally lecture and group presentations (0800-1015) with Group A lab first (1030-1200) and Group B lab following (1300-1430).

The synchronous teleconference demonstration took place at the Grosslingova High School, Bratislava on Wednesday, February 15 1800-1930. This involved the use of a video telephone teleconference between the Slovak students and a group at the University of Hawai`i Laboratory School in Honolulu. Being twelve time zones apart, students at Grosslingova came to school in the early evening while the Hawai`i students gathered before school.

Post card greetings had been written ahead of time by the Hawai`i students and hand-carried by Southworth to Slovakia. These were distributed to Grosslingova English teachers for distribution to interested students in their classes. Many then wrote individual email replies to their new "electronic pen pals" in Hawai`i before or after the teleconference. (Note: each of the Hawai`i students had Internet email accounts on the UH PLATO computer system. Email to the Slovak students was sent via the account of the school computer teacher, Mr. Karol Kyndl. The latter was very helpful and efficient in arranging details with phone line, TV monitor and videophone set-up, and email exchange.) Teleclass International of Honolulu provided loan of the videophones to the UH Lab School and Slovakia students.

Despite some delays in starting due to technical phone connections problems, the session took place smoothly and all students were very excited by the experience.

The last day of the workshop certificates of participation were presented to members of the workshop. The final task was completion of a workshop evaluation which also included feedback for improvements.

2.4 POST WORKSHOP EVALUATION

The evaluation showed that most of the participants had limited or no experience in using computer networks. They were very satisfied with the content and the majority of the participants evaluated the course as "Good" or "Excellent."

Various participants noted the limitations of technology and networking which impacted some of the demonstrations. This was especially true for use of the World Wide Web as it requires the broadest bandwidth of all the Internet resources utilized.

Final evaluation is underway at the time of publication. Preliminary data indicates the access to networks has been improving over the past year and should provide greater opportunities for workshop participants to apply the skills they learned.

2.5 IMPROVEMENTS FOR THE FUTURE

It is expected the aforementioned technical limitations will be increasingly addressed by planned hardware, software and networking advances.

The experiences gained by the co-authors is expected to be useful as they work toward publication of their workshop manual in Slovak and English. Its preliminary versions have been developed and copied for distribution to all participants.

Plans for development of local gopher and WWW resources will permit more effective information dissemination and sharing of ideas and resources for using telecommunications and searching for information helpful to individual needs.

3.0 OUTCOMES AND FOLLOW UP

3.1 HI-NEST/*FAST*

On the final day of the workshop one of the ***FAST*** Slovak schools received its first modem to attach to its newly-purchased microcomputer. Within one week of the workshop they applied their newly-acquired email and modem use instructions and logged onto their school email account to send email to Hawai`i. Indeed, several of the Slovakia ***FAST*** schools became regular HI-NEST participants as demonstrated by their regular, monthly local weather reports posted the second Wednesday of the month.

Ironically, the school sending the first email message was rarely heard from after that during the spring semester. Finally, greetings and a report from them was sent by a nearby school. "They have a problem with the telephone line," reported the computer teacher of the other school in an email report sent in June, "because the school has only one. When they want to use it for email they must carry the computer and modem over to the secretary's office." But they further reported optimistically, "...in September they'll obtain a new telephone line and then cooperation will be better."

In any case, the workshop helped provide HI-NEST participants and others a vision of future services that will be more commonly available at local schools.

3.2 ESP (EUROPEAN SCHOOLS PROJECT)

There are a growing number of associated projects and activities that utilize emerging technologies. We have begun during this project to explore cooperative activities with one of them call the European Schools Project.

The ESP began in 1988 to provide support for primary and secondary teachers and students participating in "educational telematics and teleprojects." Currently, 26 countries are involved.

In 1993 Slovakia joined ESP in cooperation with SANET, founded in 1991 to establish Internet connections for local schools. A presentation and paper on SANET and ESP in Slovakia given at the INET '95 conference provides a good review of "problems and barriers" as well as suggested experiences and future endeavors. (Weis and Krajnak, 1995) The authors point out the limitations of lack of computer literate teachers, of teachers and students not being aware of the benefits of Internet, and insufficient literature about Internet and its services. They suggest that "teachers who are beginners must be helped by means of organizing meetings and the exchange of experiences with other teachers." That certainly at least partially happened when the FAST teachers and their informatics teachers came together for the TSE workshop.

3.3 BROADER APPLICATIONS: AN EXAMPLE WITH THE PEACE CORPS

During the past year we have applied the model to other situations and organizations. One example is that of the development of a similar venture with the U.S. Peace Corps.

During the months following the workshop increased access to email was provided Peace Corps Slovakia volunteers working in schools linked to SANET. One example was documented by Paul Kim, Peace Corps TEFL (Teaching English as a Foreign Language) and ***FAST*** Mentor in Modra and Casta schools. He reported, "I am involved in the English side of the FAST program. I help teach the technical vocabulary. Each week we review and go over new vocabulary. We spend time over proper pronunciation, definitions, and I also help explain the principles in English. Doing so, we help solidify the principles they are learning in the lab, and they get to practice speaking English." He goes on to say, "We also hope to see its expansion into other schools, with the possibility of being connected with one another via the Internet. Enabling students to communicate with one another within the Slovak Republic may enable the increased dissemination of scientific data and project information. Being linked through Internet will also permit our students the chance to communicate with other students from foreign countries. Not only will this increase an exchange of information and ideas, but will expand the cultural awareness of all the students involved. For that, I hope to see the ***FAST*** program continue."

An innovative project activity was then developed in cooperation with Peace Corps Slovakia staff and the Hawai`i Returned Peace Corps Volunteers (RPCV) Association. The Hawai`i group had accepted a challenge from the U.S. Peace Corps to participate in the Diversity Initiative, a project to urge more Americans of minority extraction to join Peace Corps. Kim, a Korean-American from California, cooperated by taking colored, 35mm slides of his life and work in Slovakia as an English teacher and ***FAST*** Mentor. The "world premiere" of this project took place in June 1995 during a meeting of the Hawai`i Returned PCV's Association in Honolulu during an evening meeting. Kim reported via videophone from his classroom some 12 hours ahead early the next morning. Several students and teachers sent their pictures and greetings following Kim's narration of the slides. A spirited discussion took place between Kim and the Hawai`i audience, mostly RPCVs or prospective PCVs.

3.4 PEACE CORPS CENTURY 21 (PC21 PROJECT)

One of the more interesting follow-up activities began with more formal telecommunications training sponsored by Peace Corps Slovakia. Thanks to the connections through collaborative projects of the ***FAST***/HI-NEST project and Peace Corps Diversity Initiative, Peace Corps Slovakia invited the TSE co-authors to set up an abbreviated version of the February workshop for Peace Corps volunteers, trainees, and staff in Bratislava in early August 1995. This involved over 30 participants who met at the Slovak Technical University for the two-day sessions that featured most of the same topics as the February workshop. Portions of the manual were prepared in English for this group. ESP Slovakia Coordinator Dr. Julius Krajnak assisted in the second session.

A proposed "Project PC21: Peace Corps and the Information Highway in the 21st Century" was developed to investigate the potential of longer-range, collaborative efforts involving Peace Corps Slovakia as a pilot endeavor. The proposal views a transition in roles of Peace Corps Volunteers. While the isolated PCV working in a village and living in a grass hut still exists, there needs to be a greater vision towards Peace Corps as it is evolving in the educational programs in Slovakia and other countries. The explosive growth of Internet access around the world will call for PCVs with skills to help access information and train counterparts as we are doing in this TSE project. In this way, not only will developing countries benefit from the Internet "legacy of skills" left by the PCVs but the Peace Corps goal of "bringing the world back home" to enrich American schools curriculum and communities will be furthered by collaboration between such projects as the Peace Corps World Wise Schools, European Schools Project, and HI-NEST.

4.0 CONCLUDING COMMENTS

The TSE project was one of the first systemmatic efforts to introduce telecommunications into Slovak education. The enthusiasm of participants has demonstrated the importance of this endeavor and points to the need to similar activities between our countries.

The potential of the emerging technologies to stimulate not only the educational process but growing numbers of applications to society is an exciting prospect. We hope this project has started that process in a small way and will continue through its various participants to expand throughout their lives and those with whom they come in contact. Therefore the authors expect to develop alternative projects growing out of the new awareness and understanding of telecommunications technologies gained from TSE.

5.0 ACKNOWLEDGEMENTS

The authors and project organizers wish to acknowledge the PSSC Legacy Fund and its administrators at the San Diego State University Foundation for their generous support and undying patience in helping the project survive several major challenges during the year. The Legacy Fund and those who founded and operated PSSC should be pleased to know their efforts continue to promote educational and non-profit use of telecommunications through such grants as TSE. Dr. John Witherspoon and Ms. Stephanie Seyer were the primary administrators working with the project organizers. The University of Hawai`i Foundation was also helpful in handling transfer of the funding related to Mr. Southworth's expenses. In addition, appreciation should be expressed to those helping make the workshops a success in Bratislava: the computing centers of University of Economics in Bratislava and the Slovak Technical University where the workshops took place; for help in the Electronic Field Trip demonstrations were Mr. Karol Kyndl of Grosslingova School and students from there and the University of Hawai`i Laboratory School as well as Mr. Gene Dunton of Wandell School in New Jersey; the University of Hawai`i Computing Center for providing a demonstration account; and graduate students Dana Chuda, Peter Sloboduik and Michal Liday who coordinated the laboratory sessions for the February workshop, and members of the Peace Corps Slovakia staff in Bratislava for their excellent cooperation and assistance.

6.0 REFERENCES

Hvorecky, J. and J. Southworth, "Internet Beginners Guide to the Information Superhighway," Manual produced in Slovak and English for the Telecommunications in Slovak Economics and Business Education workshops, 60pp, February 1995.

Weis, T. and J. Krajnak, Slovak Academic Network (SANET) and European Schools Project (ESP) in Slovakia", Proceedings of the INET '95 Conference, June 1995, Pg 327-332.

CREATING AN INEXPENSIVE, NARROW-BAND, MULTIFUNCTION S/L-BAND EARTH STATION FOR THE REMOTE PACIFIC ISLANDS: A CHALLENGE TO THE INDUSTRY, CARRIERS, AND FUNDING AGENCIES

Bruce BEST* and Thomas OKAMURA**

*PEACESAT Manager, University of Guam
**Program and Information Services Manager, PEACESAT, University of Hawaii

1. ABSTRACT

The University of Guam PEACESAT (UOG PEACESAT) station provides non-profit public services to over a three million square mile area of the tropical north Pacific, generally referred to as Micronesia. Within this area, only 8 of over 200 significantly populated islands (with a teacher or dispensary) have any off-island communication facilities, except for HF radio systems. The outer islands of Yap, Chuuk, Pohnpei, and Majuro are more populated, than the INTELSAT and PEACESAT (public service telecommunications) serviced main centers. In order to network remote Micronesian medical and educational facilities, small, robust, marine grade narrow-band earth stations need to be developed.

This paper presents a vision of rugged 3 meter S/L-band earth stations strategically located over the outer Micronesian Islands that do not have INTELSAT or PEACESAT earth stations. These simple solar-powered narrow-band links would serve remote educational and medical learning centers and would provide emergency communications during environmental and natural disasters in coordinating state relief workers. We hope that the industry could provide a narrow-band single three channel (2 simplex and one duplex) transceiver, hopefully digital, earth station that could provide wide band receive only and simple voice communications, 9.6 KHz data transmission, and G-3 two-way facsimile capability for under US $15,000. The earth stations must be easy to maintain and cost efficient to operate (space segment being provided by PEACESAT at no cost to the qualified user). This network would provide basic communications for the remote islands until the LEO or "Spaceway" style GEO systems are launched and are affordable to thin route Pacific Island countries of the Federated States of Micronesia (FSM), the Republic of Palau, and the Republic of the Marshall Islands (RMI).

2. INTRODUCTION[1]

The University of Guam (UOG) is the only four-year post-secondary educational institution located in Micronesia. UOG offers 26 baccalaureate degrees in four undergraduate colleges: the College of Arts and Sciences; the College of Agriculture and Life Science; the College of Business and Public Administration; and the College of Education. In addition, the UOG Graduate School oversees the offering of Master's degrees in the areas of art, biology, business, education, and public administration.

The student body is relatively diverse. It consists of students from Guam, Micronesia, the US mainland, the Philippines, and Asia. The present enrollment is approximately 5,500 students at the main campus. In addition, the University offers a variety of courses throughout Micronesia through its Center for Continuing Education and Outreach Programs (CCE-OP).

Micronesia is about 3,000,000 square miles of ocean (more than 7 million square kilometers) and 1,045.3 square miles of land (2,707.2 square kilometers). It runs from 2.39 degrees south to 20.33 degrees north for a maximum north to south distance of 1,387.2 nautical miles (1,595.28 statute miles). The east to west distance is approximately 2,726 nautical miles (3,135 statute miles) lying between 131.10 degrees east and 176.54 degrees east. Thus it covers an area that is roughly equal to that of the continental United States (See Figure 1).

Within Micronesia, UOG has concentrated its efforts on the former American flag territories. Today, these territories are divided into five separate political jurisdictions: the Republic of the Marshall Islands and the Federated States of Micronesia, both of which are freely associated with the United States; the Commonwealth of the Northern Mariana Islands and the Unincorporated Territory of Guam, both U.S. Territories; and the Republic of Palau, the remnant of the Trust Territory of the Pacific Islands.

3. UOG PEACESAT

The primary role of the UOG PEACESAT is to provide public service telecommunications to support the Micronesian educational and medical communities.

As a regional telecommunications hub, UOG PEACESAT handles most of the emergency, disaster and medical evacuation traffic in the region. UOG also delivers college courses and seminars over the PEACESAT network to the constituents within the three million square miles of Micronesia. Combining the use of the UOG PEACESAT SSB radio, satellite RF technology, and distance education program options, the UOG outreach program and the local community in general have been able to communicate with the Micronesian region more efficiently and effectively.

Some of the emergency management users of UOG PEACESAT include the Red Cross, Federal Emergency Management Agency, Centers for Disease Control, and the Coast Guard Search and Rescue.

The FSM Consulate routes medical referral communications to and from Guam Hospital and FSM Hospitals through the UOG PEACESAT. Telephone interconnections with SSB, HF radio, and the GOES satellite systems help the FSM states in their typhoon recovery efforts. The solar powered UOG PEACESAT was the primary source of information to the outer areas of Micronesia after the Great Quake on Guam (August 8, 1993). The GOES satellite and the SSB high-frequency radio links connect the most remote reaches of Micronesia to the developed information centers around the Pacific Rim.

4. PEACESAT MICRONET -- DISTANCE EDUCATION MISSION, PROGRAMS, SERVICES, AND NEEDS.

The UOG PEACESAT provides public service, distance education and Internet via satellite to Palau, Majuro, and the four emerging island states of FSM and their respective outer islands of Micronesia. The UOG PEACESAT also established and continues to operate a HF/SSB network that reaches dozens of outer island schools and dispensaries within Micronesia. UOG services provided to the region include:

- MICRONET news and weather (international and regional) are broadcast daily from Guam, often directly into the local island's AM station.
- UOG provides UOG College of Education courses to Rota (Commonwealth of the Northern Mariana Islands, CNMI), the four states in the FSM, the Republic of the Marshall Islands, and the Republic of Palau. Most courses are live interactive voice or on-site video with PEACESAT interactive voice lectures.
- The UOG College of Nursing is currently providing interactive digitized compressed video, electronic whiteboard and digital voice over standard voice grade circuit to Palauan nurses. This exciting new distance education delivery technology is currently run over a Macintosh format and is interactive with Palau Community College. We would like to expand this service to other entities and organizations. Courses will use land line modem connections for color digital transfers combined with standard lectures that are delivered over PEACESAT voice circuits. The College of Nursing and the Palau nursing students produced short videos and exchange them via Continental pouch.
- All Distance Education services are supported by the UOG9 UNIX Internet Services combined with facsimile and modem connectivity provided through the PEACESAT system. R&D continues on Packet/duplex/ethernet extensions over to interface with the proposed PEACESAT Services Improvement Plan (SIP) that will

632

provide enhanced digitized audio-video graphics for superior distance education programming. Also, Guam is currently seeking funds for training workshops and technical development upgrade projects that will support all of the Micronesian sites.

5. COMMUNICATIONS NEEDS IN THE REMOTE ISLANDS

UOG PEACESAT has been, and continues to be, committed to providing services to the Micronesian region. Unfortunately, the current communication environment does not allow UOG to provide support to the outer islands.

The remote islands, as stated earlier, are not served by the telecommunication carriers within the region. The majority of the population base in Chuuk, Pohnpei, Yap and the Marshall Islands are not in the centers and are generally without any communication links to the children and professionals in the schools and dispensary facilities.

There are no Intelsat or PEACESAT earth stations at these remote sites. The location of Intelsat earth stations on these islands have not yet been deemed cost-effective by carriers. Further, the current PEACESAT earth stations are not configured to enable UOG PEACESAT to provide the kind of services that it is prepared to support in the remote islands of Micronesia.

The current PEACESAT earth stations support a single carrier that can be used for voice or for data, but are not designed for receiving compressed digital video at base speeds of 128 Kbps. The current PEACESAT stations are also more expensive ($35,000 with auto-tracker) than is possible for many of these small islands to purchase.

Consequently, these remote islands only have HF and SSB communications that are not fully reliable. There is a very strong need in Micronesia for the development of a small, robust, marine grade narrow-band earth station that works in conjunction with the PEACESAT system.

6. GENERAL APPROACH TO A LOW-COST EDUCATION/MEDICAL SATELLITE DELIVERY SYSTEM IN MICRONESIA

The following vision is an effective, efficient, appropriate and cost effective scenario to provide distance education and teacher training curriculum communication links to the underserved population centers in the outer islands of the emerging island nations of Republic of Palau, FSM, and the Republic of the Marshall Islands.[2]

The vision is based on the use of the PEACESAT GOES-2 satellite. The same scenario with proper hardware changes could use a commercial C-Band or Ku band space segment. However, PEACESAT is appropriate for distance education and medical conferencing as long as the traffic is limited to non-profit communications.

Currently, the PEACESAT Services Improvement Plan proposes to upgrade specific sites to 6 meter digital earth stations (Okamura and Mukaida, 1995, 1994) with wide bandwidth capability. This scenario is fine for government centers such as Kolonia, Pohnpei, Koror, Palau, Kwajalein/Ebeye area of the Republic of the Marshall Islands, Garapan, Commonwealth of the Northern Mariana Islands, and the University of Guam where a high volume traffic conduit is needed.

However, the large earth stations will cost upwards of U.S. $250,000 each and will commit the hosting government agency to a recurring maintenance and personnel cost. For the outer islands of the FSM and the Republic of the Marshall Islands, we hope that smaller, more appropriate systems can be installed for 1/10th of the cost of a 6m earth station and serve as a complement to the PEACESAT Hub Site network.

Commercial links will not be cost effective in these outer islands until LEO's or super GEO wide area satellite phone exchanges are launched and implemented sometime after the turn of the century. With over 3 million square miles of ocean, only SSB/HF radio and satellite networks may be cost-effective within the region in the near future. However, we are still not sure that the final cost of these new LEOs and GEOs will be cost-effective for the outer islands in the region.

7. FUNCTIONAL CONCEPT OF A DIGITAL VIDEO RECEIVE WITH VOICE OR DATA RETURN

The basic concept is to install and maintain a small learning resource center in the more populated outer islands. Each class room would be supplied with solar powered circuits with generator back up for the audio-video computer integrated earth station. All equipment would be DC input (12VDC VCR/ Monitors and computers are currently available), and simple to operate and maintain.

The earth stations would be small, digital and capable of up & down-linking of 9.6 Kbps with 128 Kbps digital video receive capability. The concept assumes that power required for wide bandwidth transmit capability would not be cost-effective and therefore not sustainable. The wider bandwidth receive link would allow the remote site to receive compressed color video from the originating up link facility in Guam, Saipan, Pohnpei, Hawaii, etc. A PC-based, low-speed video codec system would be used for receiving programs.

Full G-3 fax and phone links will be available along with Internet access and basically any communication device that is compatible with a phone system that can be hung on the earth station. The earth stations need not have more than 2 simplex (multiple site teleconferencing) channels and one duplex channel. The VCR system can show the prerecorded class tapes, and the remote classroom can interact via the satellite link. The earth stations can be installed for under U.S. $20,000 each and with local support can be operated inexpensively thanks to the U.S. supported GOES space segment.

In addition to the educational services a grant would fund, emergency links will utilize the 'earth alert' hand held triggered from UOG via satellite. When islanders receive an alert from UOG, they will check the SSB for details from Guam. UOG can design low powered FM broadcast stations that can be used for distance education, cultural programs, primary health care workshops, and would be available for emergency information dissemination for Tsunami/typhoon locations, search and rescue, etc. This scenario allows small $10 transistor radios to be at the homes for monitoring the local atoll's solar powered FM broadcast station, which can be fed to UOG PEACESAT Communications Hub during emergencies or distance education programming.

Figures 2 and 3 contains a general pictorial representation of this vision. Figure 2 shows how the system would be interfaced to existing HF and AM systems, as well as to emergency notification system such as Earth Alert, currently being tested by NASA.

Figure 3 shows an inexpensive 6m mesh antenna to receive digital video and have a data or voice return based on digital compression technologies. The figure illustrates the conceptual application needs of UOG-PEACESAT, but does not need to be implemented with this specific technology. Figure 3 also shows the existing PEACESAT 3m sites as participating in network through 64 Kbps digital modems. The key is not the technology that is identified but the ability to meet requirements that are generally outlined below.

8. SYSTEM REQUIREMENTS

The following are some of the requirements and parameters of the system.[3]

7.1. GOES-2 Satellite Environment

PEACESAT uses the second of a series of Geostationary Observation Environmental Satellite or GOES-2. The GOES-2 satellite is in an inclined orbit to save fuel and located at 175°W. This inclined orbit requires any system accessing the satellite to constantly track its movement through a figure eight. The nominal satellite position dimensions in the Year 2000 consist of:

North-South	+/- 15.0°
East-West	+/- 2.0°

8.1.1. The satellite link budget, based on the best available information, is:

Beam-center EIRP	54.4 dBm
Downlink beamwidth	19.6 °
Earth-edge	2.4 dBm
Earth-edge EIRP	52.0 dBm
Multicarrier EIRP	52.0 dBm
Transmit EIRP	35.4 dBm
Transmit EIRP Stability	+/- 1 dBm

8.1.2. The system has a hard limited repeater and operates in multicarrier mode. There must not be any interference or intermodulation impacts to the existing carriers.

8.1.3. All performance measures must conform with the existing PEACESAT frequency and carrier plan.

8.1.4. The azimuth of the earth station must be plus or minus 25 degrees. The GOES-2 has a global footprint. Earth stations are located in Palau, Papua New Guinea, Australia, and Oregon. All must be able to see the GOES-2 in its current location.

8.1.5. The earth station must have a dual-axis auto tracker to optimize on performance and minimize the level of operator intervention.

8.1.6. The tracking system must be compatible with the existing beacon receiver signal.

8.1.7. The operational frequencies for the GOES-2 satellite are as follows:

Transmit:	2025-2034 MHz
Receive:	1683-1695 MHz

8.2. Cost

The proposed system should cost about $15,000. This does not include the cost of the digital video receive-only codec, microcomputer, or other peripheral equipment.

8.3. Environmental Requirements

The Pacific island countries present several problems that must be accounted for in the design. The earth station requirements include design consideration of the following environmental conditions or restraints.

8.3.1. The system must be able to operate with heat and humidity.

8.3.2. The system must be resistant to salt water that corrodes metal.

8.3.3. The system must minimize the electronic components that would be outside of a building.

8.3.4. Outdoor components must be protected and replaceable in the field.

8.3.5. The antenna must have a survival wind speed of 125 miles per hour.

8.3.6. The antenna must be capable of operating in winds gusting to 60 miles per hour.

8.3.7. The tracking system must have memory and renewals, and the use of a single step-tracking capability.

8.4. Appropriate-Technology

8.4.1. The system must be designed to use as much off-the-shelf low-technology as possible that can be installed, operated, and repaired by electronics technicians.

8.4.2. The design must be based on field replaceable components to minimize the repair and maintenance problems created by the vast distances in the Pacific and the high costs of transportation and time.

8.4.3. The design of the earth stations must enable technicians in the field to diagnose problems without expensive test equipment.

8.4.4. Direct power must be used to interface with solar power batteries.

8.5. Functional System

8.5.1. The system must be able to transmit voice or data and receive digital video signals.

8.5.2 The system must be able to transmit data through multiple access channels.

8.5.3. The system must have the teleconferencing capabilities of a simplex channel.

8.5.4. The system must be able to interface with the existing PEACESAT analog simplex channels.

8.5.5. The system must be able to receive a compressed digital video receive-only signal through the QPSK digital modulation that PEACESAT uses.

8.5.6 The system must be able to support phone patching through the PSTN.

8.5.7 The system must have standard audio interfaces for microphones and for speakers.

8.6. Technology

8.6.1. The system must support widely used component parts that will not be discontinued.

8.6.2. The system must have a high reliability under the conditions specified above.

9. SUMMARY

The outer islands of Micronesia are not well-served despite similar needs for medical and educational uses of telecommunications as the main islands. Today, the outer islands are only served via HF or SSB radio links. These links are unreliable.

We are hoping that it might be possible for industry or an international funding organization to assist in the development of a system that would enable these outer islands to receive some of the programming that will be provided by the UOG and other PEACESAT Hub Sites in the Pacific Islands region. The programming would consist of voice teleconferencing, data and other information access, and the ability to receive compressed digital video at 128 Kbps. In doing so, we will take a step toward ensuring that small island communities will be able to participate in the benefits of the revolution in telecommunications and information technology, services, and programs.

BIBLIOGRAPHY

Okamura, N. and L. Mukaida (1995, September) "Public Service Telecommunications: PEACESAT," Pacific Telecommunications Review, 14-23.

PEACESAT Headquarters, Hub Site Request for Proposals, November 14, 1994.

Okamura, N. & Mukaida L. (1994) "PEACESAT: A Regional Telecommunications Alliance in Transition," Proceedings of the Pacific Telecommunications Conference '94, 811-819.

NOTES

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[1] The opinions and the interpretations in this paper are those of the authors and do not necessarily represent, nor do they purport to represent, the views, opinions, or the work programs of PEACESAT-Headquarters.

[2] The idea of a digital video receive system was developed by PEACESAT as part of its "Services Improvement Plan." Unfortunately, it has not been developed given funding limitations.

[3] The authors would like to acknowledge the assistance of Dr. Norman Okamura, Associate Specialist, Social Science Research Institute, University of Hawaii, in contributing to some of these specifications.

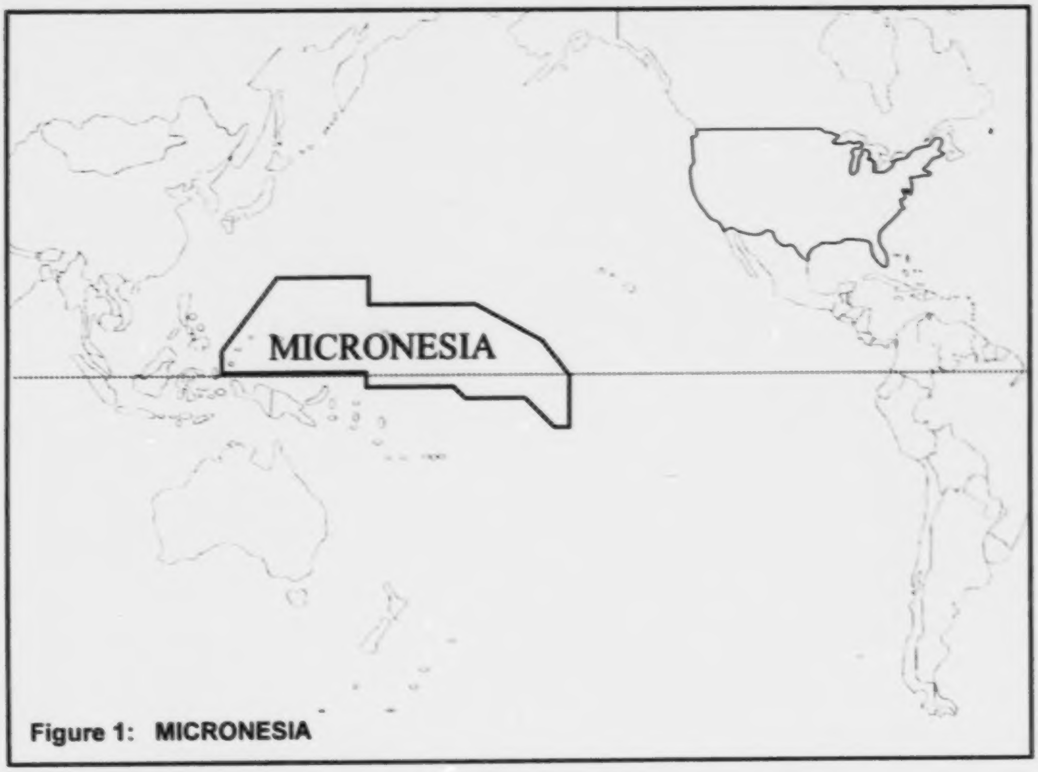

MICRONESIA

Figure 1: MICRONESIA

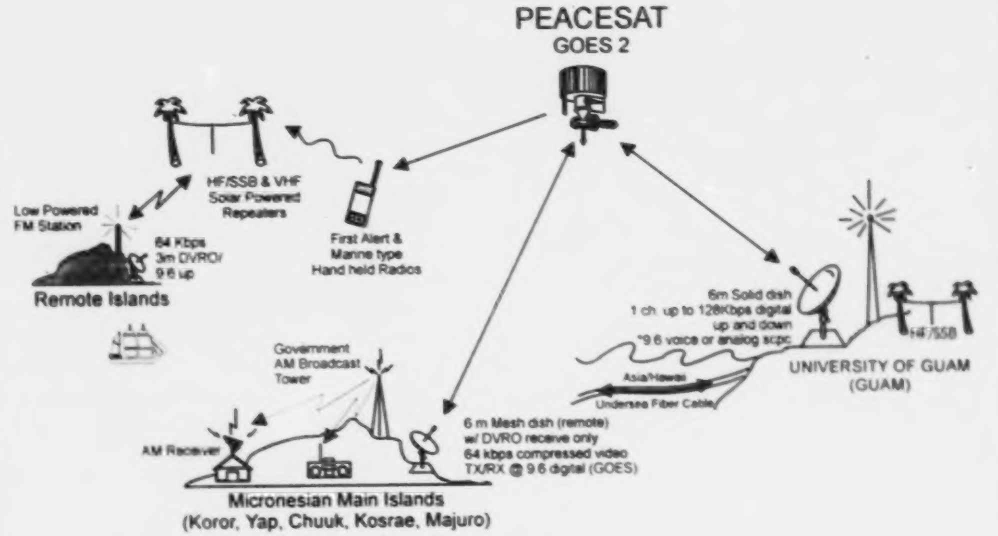
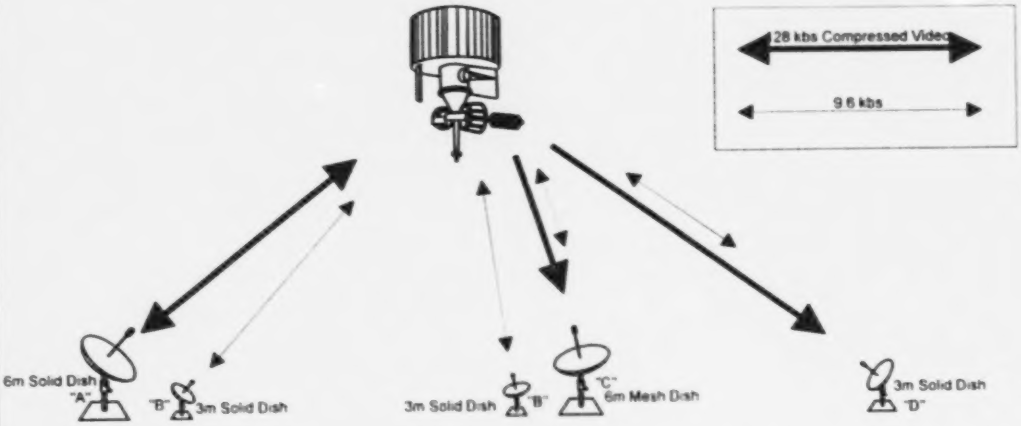

PEACESAT
GOES 2
HF/SSB & VHF
Solar Powered
Repeaters
Low Powered
FM Station
64 Kbps
3m DVRO/
9.6 up
Remote Islands
First Alert &
Marine type
Hand held Radios
6m Solid dish
1 ch. up to 128Kbps digital
up and down
*9.6 voice or analog scpc
HF/SSB
UNIVERSITY OF GUAM
(GUAM)
Asia/Hawaii
Undersea Fiber Cable
Government
AM Broadcast
Tower
AM Receiver
6 m Mesh dish (remote)
w/ DVRO receive only
64 kbps compressed video
TX/RX @ 9.6 digital (GOES)
Micronesian Main Islands
(Koror, Yap, Chuuk, Kosrae, Majuro)

Figure 2: INTEGRATING MICRO L BAND EARTH STATIONS FOR EMERGENCY MANAGEMENT, MEDICAL AND EDUCATIONAL COMMUNICATIONS

637

Figure 3: TECHNICAL OPTION FOR DISTANCE EDUCATION DELIVERY SYSTEM IN MOCRONESIA


128 kbs Compressed Video
9.6 kbs
6m Solid Dish "A"
"B" 3m Solid Dish
3m Solid Dish "B"
"C" 6m Mesh Dish
3m Solid Dish "D"

Proposed PEACESAT Hub Sites

(A) U.O.G., Palau CC, Kwajalein, Pohnpei COM, Saipan PSS

Proposed Digital "HubSite"
Up and Down link Capability of 128 Kbps
(Transponder Space Segment)

(B) Goes 3m Earth Station

Earth Stations
1 - PEACESAT Hub Site 6m Dish
1 - 3m dish

Micronesian Main Islands

(C) Site Digital Video Receive Only (DVRO)

Proposed Digital Micronesian Centers up link at 9.6 to 32 Kbps, can down link at up to 128 kbs digital compressed digital video

(B) GOES 3m Earth Station (existing)
Palau ED
Yap ED
Saipan NMC
Chuuk ED
Kosrae ED
Majuro CMI

Earth Stations
- 6m Mesh Dish

Outer Islands

(D) Proposed Digital Down link at up to 64Kbps

Goes Link (up & down)

Example:
Peleliu
Ulithi
Kapingamarangi
Mortlocks
Jaluit
Etc.

Earth Station
- 3m PEACESAT dishwith digital upgrade

Implementing Convergent Telecommunication Technologies in Universities: How Cost-Effective, How Educationally Productive?

John M Renner
Dean, Science, Technology and Engineering
Edith Cowan University
Perth, Western Australia

Abstract

Not all universities are well placed to take advantage of the continuing innovative achievements in communication technology. This somewhat sweeping claim is based on three assertions:

(i) universities are struggling to meet the financial burden of implementing the new technologies

(ii) university priorities and strategic planning have failed to fully accommodate the philosophical and practical underpinnings of enhanced communication and

(iii) skilled personnel capable of "thinking electronically" - technicians, instructional designers and university teachers - are in short supply. That is to say, we need more individuals with ability to actualise the educational opportunities offered by multi-directional interactivity, broadbanding and multimedia delivery, transparency and global networking.

Moreover, as communication technologies are adopted and implemented by universities, questions of financial accountability, performance of electronic systems and the quality of educational delivery are being asked.

This paper explores these questions and presents some compensating strategies.

1. Introduction

Universities are grappling with the problem of effectively integrating convergent communication systems into their overall strategic planning. The problem is exacerbated by insufficient briefing of senior administrators as to actual and potential advantages of enhanced telecommunications. Yet a succession of technological advances and attendant educational opportunities are impacting on our universities. Somewhat later than their commercial counterparts, universities are currently investing substantially in communication technology, building their capability for interactive multimedia delivery. Observations suggest that these emerging infrastructures and patterns of adoption and implementation of new communication technologies vary considerably from campus to campus. Whatever the variations however, there appears to be broad agreement on three counts (i) much still remains to be accomplished, (ii) financial rather than technological considerations present the greater difficulties and (iii) there is an urgent need to accompany installation of the technology with processes designed to maximise its positive effect.

Adoption of state-of-the-art communication systems by universities is by no means restricted to the so-called advanced economies. These new technologies are both the result of, and the reason for, remodelled strategic plans in universities world wide and in turn are empowering educators to institute new teaching methodologies sufficient to challenge current perceptions of "schooling", "teaching" and "learning". Edith Cowan University (ECU) in Perth, Western Australia, is currently committed to three substantial communication initiatives: (i) the expansion of existing interactive multimedia systems, (ii) investment in a cooperative multimedia centre to service an area equal to one-third of the United States of America and (iii) enhancement of the present international two-way communication system known as the Virtual Campus.

This paper addresses the challenges that accompany these three initiatives, including the financial underpinnings of communication enhancement, and suggests approaches employed to monitor their effectiveness. The approaches target (i) inputs, (ii) processes of implementation, (iii) the elements of control and support that accompany implementation, and (iv) the quality of use of the augmented communication infrastructure (ie outputs).

Finally, the paper foreshadows the emergence in universities of a new educational philosophy; one that acknowledges the new styles of educational delivery and interactivity as well as the needs and demands of students. Controversy will continue to surround these matters, further highlighting the need for more objective ways of assessing the economic and educational impacts of technological change in educational settings.

2. Enhanced Communication: A University Imperative?

Universities are not monolithic. They are complex organisations supporting an impressive number of teaching, research and commercial activities and sporting large recurrent and capital budgets. Universities are under pressure to become more cost effective and more educationally productive. But as in most multi-faceted organisations, streamlining is not easy; mistakes are made. Innovations, R & D achievements and potentially profitable projects arising in the university may be lost to more competitive organisations. Universities, along with other organisations, make flawed decisions. Expensive communication systems may be installed only to find that they have been superseded and cannot be up-graded.

Given the pace of technological change, the half-life of even the most adaptable telecommunication system is likely to be less than five years. It is not surprising, therefore, to find that much persuasive talent is required to convince senior administrators to commit substantial funding to enhance a communication network for such a short period. We might well ask in a technological climate of uncertainty, "How can universities argue a cost effective case for innovative telecommunication facilities? " Put differently, what are the direct benefits and positive spillovers arising from an investment in advanced telecommunication systems?

Realistically, the benefits/spillovers may not always be educational. Examples could include community perceptions of the university, staff needs, morale factors, flow-on of technical know-how and the diffusion of knowledge associated with new opportunities (Renner and Grant 1993). Suppliers may substantially augment a major university telecom commitment thus sugaring the pill for university administrators. Yet a balance must be struck between a catalogue of benefits including the projected educational outcomes and the allocation of recurrent funds away from other budget items.

Promoters of telecommunication systems in universities must argue on a number of fronts. **Figure 1** summarises the persuasive categories canvassed at Edith Cowan University and despite uncertainties already referred to, there is ample evidence indicating the benefits achieved by universities adopting and implementing advanced telecommunication systems. New styles of communication are emerging; new forms of educational delivery and interactivity are developing; arguably new efficiencies and cost savings are being demonstrated despite the considerable cost of high-tech communication platforms.

Pressures for change in universities are considerable. If the first five years of the nineties have shifted the focus of delivery towards learner independence the remainder of the decade will see pressures for staff and students to become more telecommunication literate; more attuned to multimedia delivery and interactivity, more aware

Within the University, the proponents of new technology must:

- Clearly state the telecommunication needs of the university
- Show how the proposal matches the university mission
- Target priorities; namely the stated, current and future initiatives of the university .
- Argue out the various technological options
- Foreshadow new opportunities; new markets arising from the adoption and successful implementation of the technology
- Anticipate possible spillovers of the technology, i.e. those likely to advantage the university
- Include monitoring procedures including user feedback and quality assurance procedures.
- Minimise risks (financial, managerial and educational)
- Account for hidden costs eg installation, training, maintenance, evaluation
- Show how the new technology will affect other divisions/functions of the University

FIGURE 1 Stating a case for telecommunication facilities in a university - guidelines covering propositions for adoption and implementation of technology

of the global educational opportunities (Renner, 1995). "Imagine a University that comes to you", says a recent advertisement, implying that university outreach capability could make an important contribution to a university's success. Building on proven local performance, universities are now seriously considering program delivery nationally and internationally. Distinctions between on-campus and off-campus delivery will diminish. Already, for example, at Edith Cowan University on-campus students are choosing electronic delivery through the Virtual Campus to augment in-class lectures (Corrigan and Renner, 1995).

Predictably, university hinterlands will expand and overlap. Instructional designers, multimedia managers and technicians will assume greater importance. University teachers (and students) will be challenged by new styles of delivery, new ways of enhancing learning. Students at a distance will recognise their teachers from digital images on computer screens. Assignments will be prepared, delivered and assessed without touching paper. Creative teaching will include multimedia packaging and convergent communication applications to augment more traditional best practice. That is to say, to survive in the information age, universities must also become leaders in the development and use of quality electronic courseware, delivery systems, flexible and stimulating to the learner, responsive to student feedback and subject to regulár review. Only then will the implementing of enhanced communication systems become a university imperative.

3. Implementing Effectively: Ways of Knowing

"Our feeling is that ongoing evaluation should be a far more rigorous and formal aspect of program operation". (Anderson and Lattimore, 1995, p17.)

It is helpful to structure this section of the paper around a set of questions:

- How should universities assess current telecommunication technologies in terms of program delivery?
- How do we know that a delivery system is effective?
- What are the critical dimensions of technology assessment?

So how should universities assess these new emergent interactive technologies? The short answer is creatively, objectively and variously. (i) Renner (1993) has proposed a set of strategies derived from earlier work by Hall, to measure the level of implementation, the scope of implementation and the quality of implementation of a given technology. The example used by Renner was a fully interactive broadband television delivery system. (ii) More recently Cheng et al (1995) have suggested a set of nine questions to be asked by an instructor before embarking on an interactive multimedia project. In effect, Cheng anticipates embedded evaluation

- Will the subject benefit from an interactive multimedia treatment?
- Will it help students learn better by using electronic delivery?
- Have all the possibilities of interactive multimedia linkages been explored?
- Will formative evaluation be used to test and revise the effectiveness of multimedia delivery?

FIGURE 2 Prior questions used to assess multimedia delivery (from Cheng and Cheng, 1995).

and goes on to claim that affirmative answers to these questions will require a new approach both to the technology and the program. A sample (re-worded) of four of Cheng's questions appear in **Figure 2.** (iii) Using methods derived from sociology literature, Priest et al (1995) assess I.T. systems from an investment perspective. (iv) McNaught et al (1995) have assessed the effectiveness of multimedia delivery by seeking instant electronic feedback from student users. (v) Likewise, in various Virtual Campus evaluations, students have been asked for their anecdotal and judgemental responses against specific evaluation criteria immediately following their use of the system.

In all the options of technology and program assessment the evaluation data are drawn from the participant including the technical staff, instructional designers, instructors, students and university managers/decision makers. Methods used to collect relevant data include: responses from the project team, structured interviews, e-mail feedback (e.g. dragged words on a computer screen by users), questionnaires, anecdotal comment, consultants' reports and experts' reviews. Perhaps an attempt should be made in future appraisals to include the developers of delivery platforms (hardware and software) as well as the users. Studies by Renner (1993, 1994) confirm that difficulties experienced by multimedia users relate to insufficient promotional effort, insufficient technical support, unresourced project leadership and insufficient expenditure on the delivery system. Details of methodologies used will be found in the cited references.

Is the system effective? In the light of this research, a set of questions has been designed to assist universities that wish to assess the effectiveness of adopted telecommunication technologies. (**Figure 3**). It will be noted, surprisingly perhaps, that less than half of the questions target the technology directly. The remainder cover support systems, the implementation process and a range of contextual issues. The evaluation process is also facilitated by the visual display of an implementation model (**Figure 4**), one that specifies and highlights the prime input, interaction and output variables, each to be targeted during the evaluation exercise.

- Is the University committed to an agreed functional/sequential model covering implementation?
- Does the chosen technology (or alternatives) meet the stated objectives?
- Who are the participants and how do they contribute to implementation?
- What is the nature of support within the University?
- Are there time constraints; is there an implementation time-frame?
- What kinds of feedback are expected by decision makers, users, support personnel?
- What assessment instruments are most appropriate to achieve the desired feedback?
- What implementation processes have been identified and how are they best facilitated?
- The report: its purpose, the readership?

FIGURE 3 Is the system effective? Guidelines for effective evaluation of the implementation of telecommunication technologies.

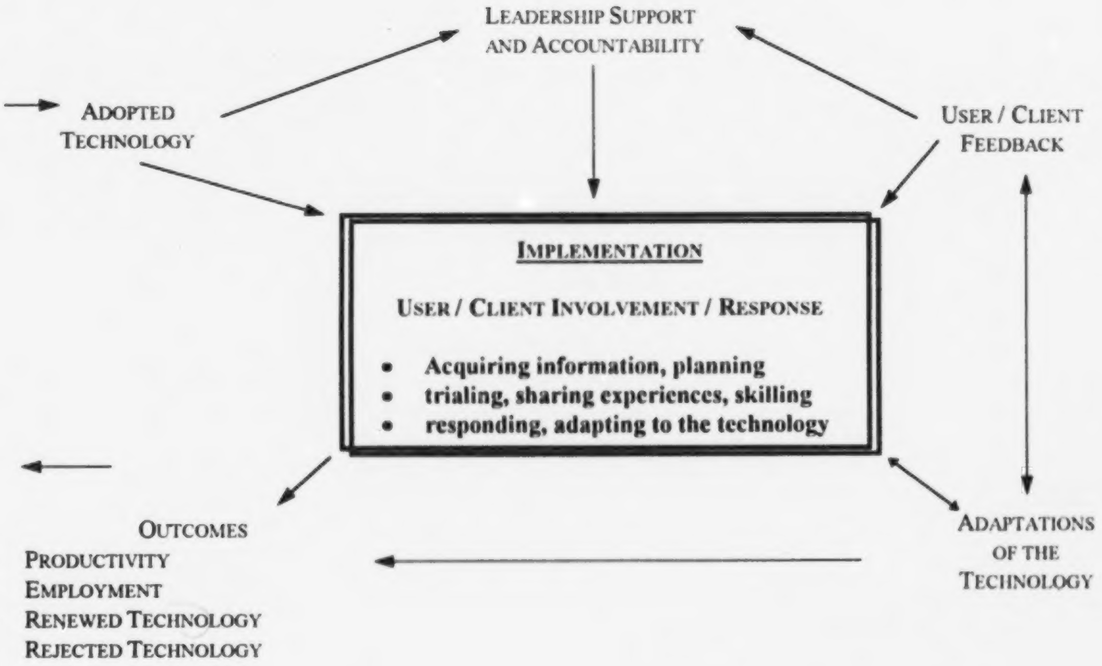

LEADERSHIP SUPPORT AND ACCOUNTABILITY
ADOPTED TECHNOLOGY
USER / CLIENT FEEDBACK
IMPLEMENTATION
USER / CLIENT INVOLVEMENT / RESPONSE
• Acquiring information, planning
• trialing, sharing experiences, skilling
• responding, adapting to the technology
OUTCOMES
• PRODUCTIVITY
• EMPLOYMENT
• RENEWED TECHNOLOGY
• REJECTED TECHNOLOGY
ADAPTATIONS OF THE TECHNOLOGY

FIGURE 4 A conceptual model of implementation with particular reference to the introduction of new technologies

Finally, what are the critical dimensions of technology assessment? Aside from the participating technical staff, instructors, students and administrators, all of whom have opportunity to influence the effectiveness of education delivery, six broad dimensions of implementation merit examination (**Figure 5**). Again, each dimension deserves consideration by decision makers in universities.

Clearly, monitoring the effectiveness of new technologies, new processes and new educational procedures has potential to become complex and burdensome. There is comfort however in the knowledge that useful feedback can be obtained with a small investment of time and effort. It is claimed here that wherever possible, feedback should become an integral part of program delivery, responses should be sought from each participant group, dialogue should result with developers, suppliers and local technical support as well as with those closely associated with courseware. And finally, Anderson and Lattimore's exhortation at the commencement of the section should be heeded.

- Reliability within the university environment
  - does the system perform as predicted?
- Efficiency in terms of stated requirements
  - does the enhanced technology improve job efficiency?
- Output associated with use levels and effectiveness
  - does it improve productivity of use?
- Innovative Spinoff of the system in uni departments
  - is there innovative flow-on?
- Overall Impact across the university
  - is these overall acceptance/benefit from the enhanced system?
- Implementation/Investment Effectiveness i.e. accountability
  - is the investment judged to produce substantial benefits to the university?

FIGURE 5 Implementing Advanced Telecommunication Systems: Emerging Critical Dimensions

4. Concluding Comment

In this issues paper, it has been claimed that universities face an uncertain future. The most impressive changes in telecommunication technology ever experienced are now offering revolutionary possibilities. But are our universities sufficiently flexible, sufficiently committed to new forms of educational delivery to make the necessary changes? Many have taken a small step into the world of interactive telecommunication. Others watch and wait. Still others like the National Technological University are totally committed. These varied experiences confirm that the changes ahead are not only technological. Coursework, instructional design, teaching practices, skills, attitudes and knowledge of evolving technologies by instructors must change.

The suspicious and unconvinced amongst us see technologically-driven change dominating the educational process (Postman 1993). They see universities being shaped and directed by non educational external forces. One might well ask who are the change agents? Creative salespeople, enthusiasts within the universities, prospective students seeking access to quality university education? And how do we know that the new communication technologies will be educationally beneficial? This paper has attempted to overview these questions and the attendant issues. No solutions are presented; rather a framework for universities to use as they attempt to dig below the hype and the legitimate enthusiasm to determine the most appropriate use for high-tech delivery platforms.

References

Anderson. U. and Lattimore, R. (1995). Lessons from the BIE Program Evaluations, unpublished paper, Bureau of Industry Economics, Canberra

Cheng Choo Khoo and Cheng Teik Lou (1995). Ways of Solving the Interactive Multimedia Headache in Instruction, Apple Innovation, Integration and Implementation Conference, Perth, July 1995.

Corrigin, M. and Renner, J.M. (1995) Virtual Campus: taking the university to the students,, Proceedings, 5th International Conference on Internationalising Enrepreneurship, Education and Training, Bunbury, Western Australia, June 1995.

McNaught, C et al (1995). Evaluating the Impact of Technology on Student Learning in Higher Education, Apple Innovation, Integration and Implementation Conference, Perth, July 1995

Postman, N. (1993). Technopoly: the surrender of culture to technology, New York, Knoff.

Priest, J. G. et al (1995). Investigations of Factors that Strongly Influence the Outcomes of Information Technology Systems Investments, IEEE Management in Engineering Conference, Singapore, June 1995.

Renner, J.M. and Grant (1993). Implementation of a Full Bandwidth Optical Fibre Network at Edith Cowan University, Research Report, Perth, ECU and Telecom Australia.

Renner, J.M. (1993). Enhancing the Quality of Engineering Education through Interactive Television: an evaluation of video networking in Western Australia, Proceedings, Australasian Association of Engineering Conference Auckland, New Zealand, December 1993

Renner, J. M. (1994). Convergent Electronic Networking: an interactive delivery system for distance education students in Australia, Proceedings, UNESCO Conference on International Networking, Perth, Western Australia.

Renner, J. M. (1995). Convergence of Communication Technologies to Achieve Educational Excellence: a case for the Virtual Campus, Proceedings, 17th Annual Pacific Telecommunications Conference, Honolulu, Hawaii, January 1995.

Designing Satellites for the Asian Region

David J. WHALEN and LIANG Sun-Liang
Asia Satellite Telecommunications Co. Ltd
Hong Kong

Abstract: A variety of economic, technical, political/regulatory, and demographic factors affect the design of satellites for the Asian region. These factors are discussed and the AsiaSat experience is used to illuminate some of the effects of these factors.

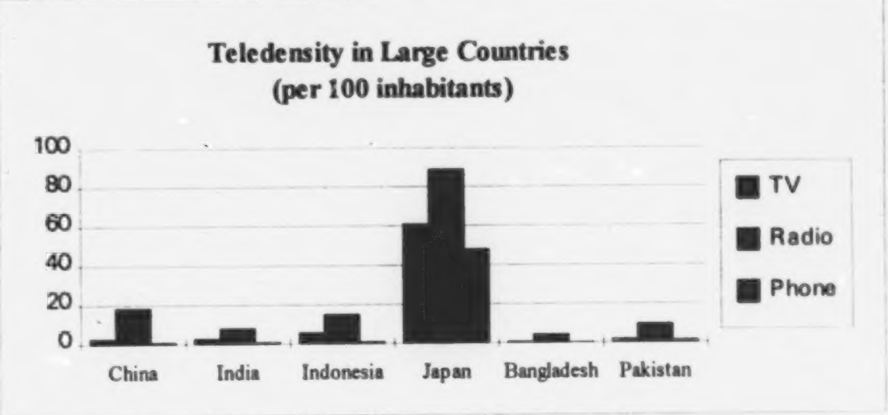
1. Introduction

The countries of the Western Pacific range from small islands to huge land masses, from crowded developing countries to underpopulated highly industrialized countries, from city-states to World Powers. Designing a regional communications satellite system to satisfy all of their needs is a challenging task. AsiaSat 1 was an attempt to determine if there was a market for an Asian regional satellite system. Future satellite designs will be tailored to the market Asia Sat 1 discovered.

2. Teledensity: Telecommunications Supply and Demand

The Asian region contains a majority of the world's population. Several of these nations have significant political and military power, but currently only one, Japan, has significant economic power. Although it is not clear whether telecommunications fosters economic growth or economics fosters telecommunications growth, it is clear that the two are related. As figure 1. below indicates, the teledensity is low in all but one of the larger Asian Countries.

Figure 1. Teledensity: Large Countries



This difference seems to be most exaggerated in the density of telephones. The teledensity (phone) is well over 40 in Japan and about one or less in the other five large countries. The teledensity (radio) has the smallest ratio between rich and poor. The TV teledensity seems to be intermediate between telephone and radio.

The three figures below (2-4) indicate the teledensity in high (>US$10,000/capita) medium and low (<US$1,000/capita) income countries. Some overlap (S. Korea and Indonesia) has been forced to allow some comparison of the significance of the income boundaries.

This dichotomy is striking. In general teledensity (phones) seems to fall into two categories; (1) over 40 for high income countries, and (2) <1 for low income countries. The teledensity figure for radio and TV show a similar, but much less striking dichotomy. This suggests that there exists a threshhold effect in telecommunications--and possibly in general economic development.

Figure 2. Teledensity: High Income Countries

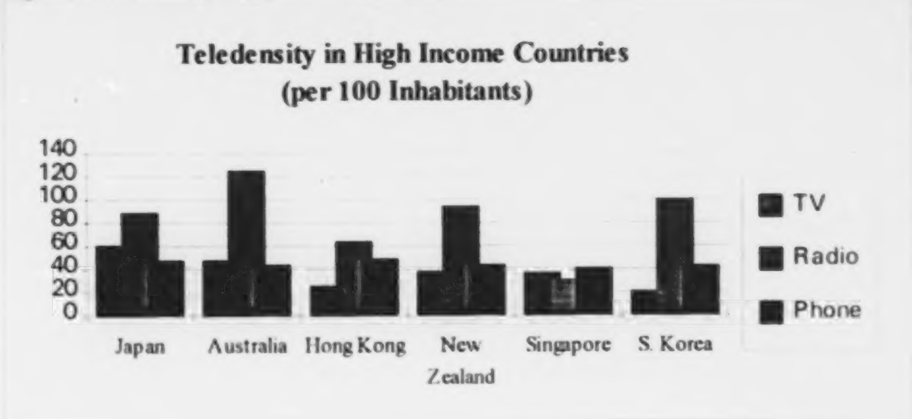


Figure 3. Teledensity: Medium Income Countries

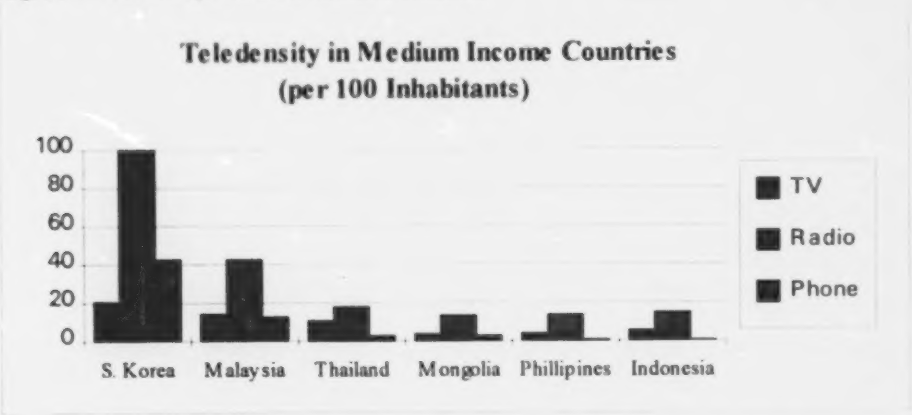
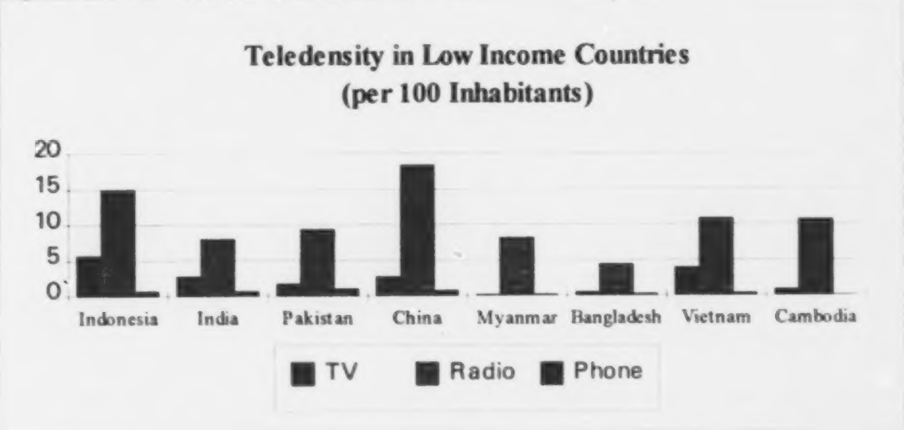
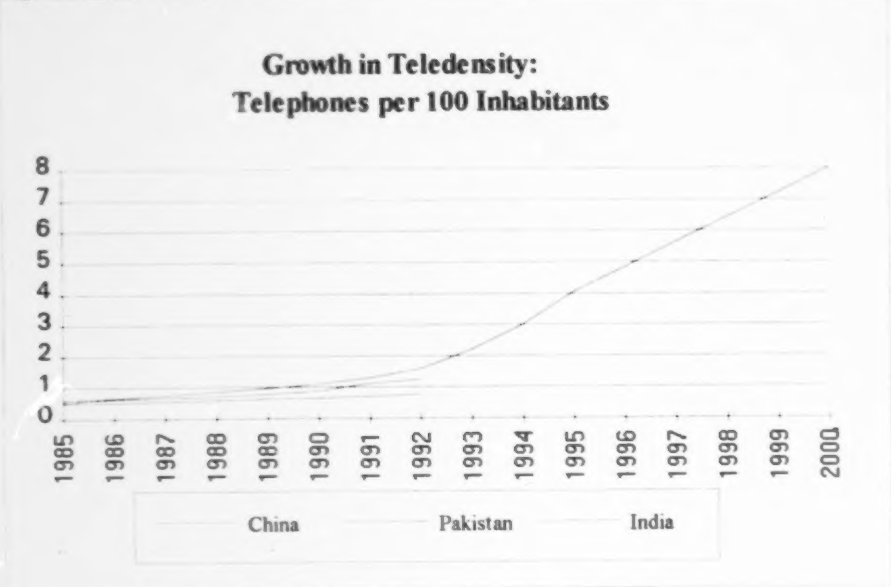


Figure 4. Teledensity: Low Income Countries



The statistics used to construct the figures above are generally from 1991. Figure 5. below illustrates the speed with which these teledensity statistics can change. China expects to reach a teledensity of 8 by the year 2000. If economic growth and tele-density are indeed correlated, this suggests that the Chinese economy will likewise grow dramatically over the next decades--as will other Asian economies.

Figure 5. Teledensity: Growth



3. Frequencies: Technical Constraints on Telecommunications Supply

Since the late 1950s, a number of frequency bands have been allocated to satellite services by the ITU. These have different propagation characteristics and have been allocated among three services: Fixed Satellite Service (FSS), Broadcast Satellite Service (BSS), and Mobile Satellite Service (MSS).

L-band Lower frequency systems allow broad beams with large antennas. This is particularly suited for MSS. L-band (1.6/1.5 GHz) provides this capability. The wide beamwidth can be a drawback when used for other services as it allows interference from other transmitters.

S-band S-band (2 GHz) is allocated among all services, but seems to be most usefull for MSS and to a lesser extent BSS systems. This band has propagation characteristics similar to L-band.

C-band C-band (6/4 GHz) was the original frequency band used for commercial FSS on the Intelsat satellites. C-band is not particularly susceptible to rain attenuation and provides 800 MHz of spectrum. Power flux density in the downlink is limited because of potential interference to terrestrial users. C-band GEO satellites are typically separated by 2 degrees of longitude or more. This limits the minimum antenna size to a little less than 2 meters. Smaller antennas will have wider beamwidths encompassing the signals from adjacent satellites.

At C-band, to cover an area like China (about 10^6 km^2) the required antenna gain is about 33 dBi. C-band coverage similar to that of AsiaSat 2 or 3 requires an antenna gain of about 26 dBi. A 5-watt TWTA would therefor provide an EIRP of about 38 dBw over China or about 31 dBw over Australasia.

X-band The X-band frequencies, 8/7 GHz , have been used primarily for military purposes, but commercial use is beginning. This frequency band has characteristics similar to C-band, but is less crowded.

Ku-band Ku-band comprises two separate bands, 14/11 Ghz (or 14/12) for FSS and 18/12 for BSS. The 12 Ghz downlink is not shared with terrestrial systems and is therefor not constrained to the same power flux density limits as is C-band. Ku-band is subject to rain-fading. This rain fading typically requires margins 3-6 dB greater than C-band. Because the downlink frequencies are three times higher than at C-band, Ku-band antennas can be one third the diameter of C-band antennas without having beamwidths so wide that adjacent satellite signals are also received.

Ka-band The very high rain losses associated with Ka-band (30/20 GHz) and the lack of terrestrial experience at these frequencies have made it the last of the FSS bands to be used. Ka-band services are particularly suited to situations where a short outage is acceptable. Recently, interest has been raised in Ka-band data-only, packet networks over satellite links.

4. Applications: Broadcasting

Satellite systems are particularly suited for point-to-multi-point (broadcast) services. A single satellite downlink can be received by an unlimited number of receivers throughout the coverage region. During the early 1960s telephony became the primary application of communications satellites, but since the mid-1970s television broadcasting has dominated.

Video Satellite television has probably been the single most important causal factor in the growth of the "global village." Television receivers are relatively inexpensive and require very little infra-structure. Satellites are suitable for video distribution, for direct-to-home (DTH) broadcasting, or anything in between.

Voice/Music Most countries, even the lowest-income, have fairly well-developed broadcast radio coverage. Satellite radio is just beginning to grow, but may become a significant part of the market demand for satellite services.

5. Applications: Telecommunications

Traditional point-to-point telecommunications (telephony, telegraphy, telex) was the initial focus of communications satellite providers. As satellite EIRP (power) grew, antennas shrank and new services became possible. Where the multi-million dollar cost of early earth stations could only be justified by dozens or hundreds of telephone circuits, the newer, smaller antennas can be cost-justified by a single voice circuit.

Heavy Route/Medium Route Traditional heavy-route (1000 circuits) earth stations which provided the long-distance connections between continents have been the province of Intelsat. Some countries began to use Intelsat for medium-route (100 circuits) in-country use in the 1970s about the same time that national satellites began to appear. All of these emphasized traditional PSTN.

VSAT The advent of national satellites provided increased EIRP which allowed the use of 10 meter antennas rather than the 30 meter antennas used initially for transoceanic traffic. As power went up, still smaller antennas became feasible. These very small aperture terminals (VSAT) could be arranged in networks for private line voice or data services.

USAT As EIRP grew higher and higher, especially at Ku-band, newer services using ultra-small aperture terminals (USAT) began to appear. National (domestic) satellites provided EIRP about 10 dB higher than Intelsat when they first appeared. The initial 32 dBw C-band coverage slowly increased to near 40 dBw today. Ku-band covergae started at about 42 dBw to provide rain fade margin, but has increased to almost 50 dBw today. These high power Ku-band satellites make possible the use of antennas smaller than 1 meter. The single voice-circuit "satellite telephone booth" is rapidly becoming an economically realizable product. Satellite rural telephony may be the most important future application.

6.Applications: Data

Data, in the form of telegraphy/telex, was one of the early uses of communications satellites, but since the late 1970s has begun a more rapid growth phase.

Current Usage A variety of data applications are currently implemented on C- and Ku-band systems. These range from very high-rate data "pipe-lines" using large fractions of a transponders to POS/Inventory and ATM/Banking applications using VSAT networks. These applications typically enjoyed the normal 99.99% availability associated with standard satellite communications practices.

Ka-band In the last few years interest in the use of Ka-band has grown substantially. Several potential providers of extremely high data rate services using Ka-band have filed for orbit-spectrum allocations. Availability is expected to be between 99% and 99.9%, much lower than the 99.99% of standard satellite communications, but with modern coding algorithms and packet switching no interruption should be "visible" to the user.

7. Applications: Mobile

There has been much discussion recently regarding the provision of mobile satellite services (MSS). This application began with the 1976 launch of the first GEO Marisat. Since that time Inmarsat, modeled on Intelsat, was established to service this need. Like Intelsat, Inmarsat is now facing competition from national and regional providers of MSS.

LEO The most notorious of MSS systems are the "big LEOs," such as Iridium and Globalstar. These systems will be in inclined orbits about 1,000 kilometers above the surface of the earth. The advantage of low earth orbit (LEO) is the greatly reduced power required of the uplink--which may be handheld. These systems are by their very nature global.

MEO Medium earth orbit (MEO) systems attempt to balance the benefits and constraints of both LEO and GEO. Orbiting at approximately 10,000 kilometers above the surface of the earth, they need less energy than GEO systems, but more than LEO systems, in the uplink transmitter. Oddyssey and ICO (Inmarsat-P) are examples of these systems.

GEO The first global MSS systems were in GEO. The first national/regional MSS system, MSAT, is also a GEO system. Several Asia-Pacific GEO MSS systems are in various phases of development.

8. Coverage: Regional and Local Telecommuncations Demand

Although the Asian region has many unifying characteristics, it also has a large number of differences reflecting nationality and language variations.

Language Specialization Three languages are prominent in the Asian region: Chinese, which has the greatest number of speakers; Hindi, which has the second largest number of speakers; and English which is a major language of business. When providing broad-cast services, and even telephony, this language specialization should be kept in mind.

National Specialization Some countries have very strong "national" cultures. There may be an argument for providing "national beams" to each of these nations.

Regional Coverage Perhaps the strongest argument for regional coverage is from the business and trade point-of-view. Large organizations need to communicate simultaneously with Beijing, Bangalore, Jakarta, Tokyo, Shanghai, and Sydney. Similarly, broadcasters may wish to have a single footprint to distribute their entire programming menu. Especially in South East Asia, there will be markets for Chinese, Hindi, and English programming.

9. Orbit-Spectrum: Regulatory Constraints on Telecommunications Supply

The rapid growth of satellite communications in Asia has resulted in the uncovering of regulatory problems that had always existed, but had not caused as many problems heretofore.

Paper Satellites In the rush to stake a claim on the geosynchronous arc, many organizations filed for a multitude of positions in the hope of being able to coordinate a few. Some filings were for future satellites and even for satellites that were never meant to fly. Of all the Asian satellite systems which have been filed with the ITU, many will never be launched. When a legitimate organization attempts to file for a position it will encounter a bewildering array of filings which appear to cover all potential locations.

Scofflaws No satellite operator has yet operated a satellite without ultimately obeying the procedures laid down by the ITU, but several have sailed very close to the wind. It is not clear that local administrations will always be in a position to penalize scofflaws--yet the ITU has no power (and no interest) to do so.

Sale and Lease of Rights The orbit-spectrum resource is the property of all humankind. It should be used efficiently and equitably. It would seem improper to sell rights in this resource. Much interest has been raised by the selling and auctioning of local spectrum rights by national administrations. Most of these administrations have indicated that they felt that the selling or auctioning of international spectrum rights would not be proper.

10. Designing Satellites for the Asian Region: The AsiaSat Experience

AsiaSat was the first privately-owned Asian regional communications satellite operator. Its attempts to design satellites for this region will be used to illustrate the problems and opportunities.

AsiaSat 1 AsiaSat 1 was an existing HS-376 satellite, previously Westar-6, which was refurbished by Hughes Aircraft Company for the use of AsiaSat. The existing satellite had 24 C-band transponders at two polarizations. AsiaSat's design freedom was limited to the choice of footprint/coverage. A single beam covering all of Asia would have reduced the edge of coverage EIRP below the minimum 33 dBw required for typical TV distribution and VSAT systems. Two beams seemed to be required, one for each polarization. The design question came down to deciding whether the two beams should be East and West (the initial choice) or North and South (the final choice). Details of the satellite and foot print are provided below.

AsiaSat 1 is a Hughes HS-376 spin-stabilized spacecraft (Figure 6) with 24 36MHz C-band transponders. It weighted about 1250kg at launch and now weighs about 500kg (EOL) in orbit. The power subsystem generates about 670 Watts (EOL) of DC power. The 24 8.2 watt TWTAs generate about 200 watts of RF power. Since there are no linearizers, multiple-carrier traffic can use only about 35% of the available power. The expected fuel-life of AsiaSat 1 is nine years.

The AsiaSat 1 antenna is a offset-feed Dual Gridded Surface (1.52m) with a multi-feed system comprising 12 elements used to produce two beams with different transmit and receive polarizations.

The AsiaSat 1 footprints consists of a China beam (The Northern beam, Figure 7) and a combined South-East Asia/South Asia beam (the Southern beam, Figure 3) which span more than 38 countries from Tokyo in the East, to Bahrain in the West; from Russia in the North, to parts of Indonesia in the South and embrace over 50% of the world's population.

AsiaSat 1 capacity is fully leased out--and has been since 1991. The traffic includes:

1) Regional TVBroadcast: STAR TV
2) Domestic TV Broadcast: Mongolia TV, Yunnan/Guizhou Provincial TV, etc.
3) Domestic Radio Broadcast from China (Ministry of Radio, Film and Television).
4) Regional Telephone Network: Hong Kong and Laos.
5) Domestic Public Telephone Network: Myanmar.
6) Domestic VSAT Networks: mainly in China, but also in other countries like Malaysia, Pakistan.
7) Regional VSAT Networks: Hong Kong and China, Hong Kong and Mongolia, etc.
8) Regional IDR links: Singapore and Pakistan, Hong Kong and Russia.

About 2/3 of the traffic on AsiaSat 1 is broadcast service and 1/3 is (voice/data) tele-communications. About 50% of the traffic is regional and 50% is domestic.

AsiaSat 2 While very little design work went into AsiaSat 1, AsiaSat 2 was a different story. AsiaSat 1 was a gamble--no one knew what the Asian regional market for satellite communications would be. By late 1991 it was clear that AsiaSat 1 was a success. The single most important part of that success was broadcast television--especially STAR TV. AsiaSat's initial experience suggested that two geographic market categories existed: a pan-Asian market and several national markets. The basic design criterion for AsiaSat 2 was to design a footprint covering the pan-Asian market with a single C-band beam (instead of the two AsiaSat 1 beams) and another footprint covering the Chinese national market with a single Ku-band beam.

AsiaSat 2 is a MM7000 3-axis stabilized spacecraft (Figure 9) from Martin Marrietta (now Lockheed Martin) equipped with 24 C-band transponders (20 36MHz and 4 72MHz) and 9 54MHz Ku-band transponders. It weighed almost 3500kg at launch and will weigh just under 1500kg (EOL) in orbit. The power subsystem generates about 5000 Watts (EOL) of DC power. The TWTAs are of 55-watt for C-band and 115-watt for Ku-band gererating about totally 2400 watts of RF power. All trans-ponders are equiped with linearizers, which makes the usable power in multiple-carrier case up to 50% of the available power. The expected fuel-life of AsiaSat 1 is over 13 years. The AsiaSat 2 cost/transponder/year is significantly less than the AsiaSat 1 cost.

Although AsiaSat 2 is less than three times the mass of AsiaSat 1, it has about seven times the DC power. Increased efficiency leads to an even greater ratio of RF power of 12:1.

The AsiaSat 2 antenna system is a very compact design in which two shaped Dual Gridded Surfaces (DGS) produce 4 beams: two identical C-band beams with different polarizations and two identical Ku-band beams with different polarizations. The C-band reflector size is 2.2m and Ku-band is 1.8m. Since the reflectors are shaped, only one feed is required for each polarization resulting in a total of 4 feeds.

The AsiaSat 2 C-band beam resembles a huge triangle (40dBW at the center of coverage, Figure 10) stretching from Egypt to Kamchatka to New Zealand. The Ku-band beam is dedicated to China and has a peak EIRP of 53dBW (Figure 11).

AsiaSat 2 capacity is almost fully booked. Traffic includes TV broadcast (mostly compressed digital), VSAT (domestic and regional), and IDR (domestic and regional). It is estimated that about 2/3 of the C-band capacity and Ku-band capacity will be for broadcast services and the other 1/3 will be domestic and regional VSAT and IDR services.

AsiaSat 3 AsiaSat 3 was designed in the light of five years experience with AsiaSat 1 and the rapid leasing of AsiaSat 2 capacity before launch. The existence of pan-Asian and more fragmented national markets became even clearer than it had been when AsiaSat 2 was designed.

AsiaSat 3 will be similar to AsiaSat 2 in most aspects. It will be 3-axis stabilized satellite and will have 15 years of fuel-life. Figure 12 shows the configuration of the AsiaSat 3 satellite. There will be 28 36MHz C-band transponders and possibly 16 54MHz Ku-band transponders. The C-band beams (Figure 13) will be similar to that of AsiaSat 2 and the Ku-band will have three beams (Figure 14, 15 & 16). It will weigh about 3550kg at launch and just under 1800kg (EOL) in orbit. The power subsystem generates about 8300 Watts (EOL) of DC power. The TWTAs are 60-watt for C-band and 138-watt for Ku-band gererating about 3740 watts of RF power. All transponders will be equiped with linearizers. The satellite is expected to be launched in 1997.

The expected AsiaSat 3 cost/transponder/year is about half the cost for AsiaSat 1.

It is likely that the broadcasting will still occupy an important place on AsiaSat 3, even though digital video compression techniques will reduce the bandwidth required for video by a factor of 4.

AsiaSat 4 AsiaSat 4 is being planned at this time. The evolution of the markets created by the first three AsiaSats will determine its payload characteristics. The following factors will have to be taken into account in design of AsiaSat 4:

1) Capacity required for international broadcasters may be nearly saturated,, but there is still need for more capacity for regional broadcasters.
2) Many Asian countries will have launched their own satellites.
3) Some developing countries will not have buy their own satellites, but may still need satellite services to satisfy their broadcasting and telecommmunications requirements.
4) More regional satellites will be launched which will have coverage similar to AsiaSat 2 and 3.
5) Frequency resources will be scarcer and interference between satellites will increase as more and more satellites are being lauched.
6) New applications currently unimagined may be introduced.

General considerations To be competitive, the satellite cost/transponder/year must be low and the satellite should have as many different beams at different frequencies as needed to satisfy different customer requirements. As it is difficult to predict at the moment of design the distribution of transponders over each beam, some kind of switching must be considered.

11. Designing Satellites for the Asian Region: The Future

The only predictable characteristic of the future is that it will be different. Some trends in satellite manufacturing, regulation, technology, and services are visible. These are addressed below.

Production-Line Satellites A very evident trend in satellite manufacture is the emphasis on standardization in spacecraft design and productions processes. Lower costs and higher reliability can be achieved by building one design for a relatively large number of satellites. The Hughes HS-376 is an example of this trend. These satellites are almost identical except for the beam shaping.

Customized Satellites In the past, every satellite was custom-built to a unique design. This is no longer possible as the production-line satellites are clearly the wave of the future. The standard HS-376 satellite mentioned above, tyoically had a payload of 24 C-band transponders in two polarizations. This "standard" payload may be no longer the preferred payload. Although the production line satellite "bus" may be here to stay, payloads may vary dramatically to serve customer needs and the vagaries of coordination and regulation.

Regulation There are few orbital slots left unclaimed for traditional C- and Ku-band satellites. In many cases another satellite could be "co-located" if very specific frequencies, polarizations, and geographic service area could be coordinated. These very specific payloads may be vastly different from the "standard" payloads of the past. The crowding of the geosynchronous will require new technical and regulatory efforts. There has been much said over the last several years regarding practices that are seen as improper, but which the ITU has no power to control. Solutions to these problems must be found if chaos is to be avoided.

New Technology Two new technologies are already entering the marketplace: LEO satellites and Ka-band satellites. Other frequencies and technologies are sure to appear and may dramatically change the market.

New Services Two new services, Ka-band data transmission and hand-held MSS, are soon to enter the market. Rural telephony is beginning what may be a sharp growth rate. New services, like new technology, are very often completely unforeseen until they are obvious. We can only look forward to more change resulting resulting in more and better communications services in Asia.

Note: Statistics from ITU, **Asia-Pacific Telecommunication Indicators** (Geneva: ITU, 1993).

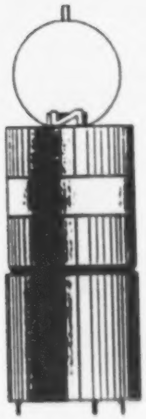
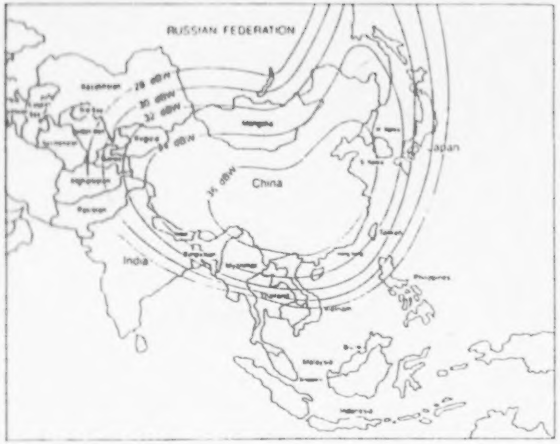
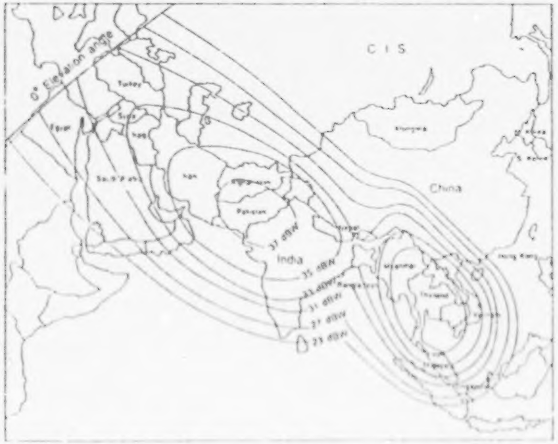


Figure 6 AsiaSat 1



RUSSIAN FEDERATION
28 dBW
30 dBW
32 dBW
34 dBW
36 dBW
China
Japan
India

Figure 7 AsiaSat 1 Northern Beam, EIRP



0° Elevation angle
C I S
China
India
37 dBW
35 dBW
33 dBW
31 dBW

Figure 8 AsiaSat 1 Southern Beam, EIRP

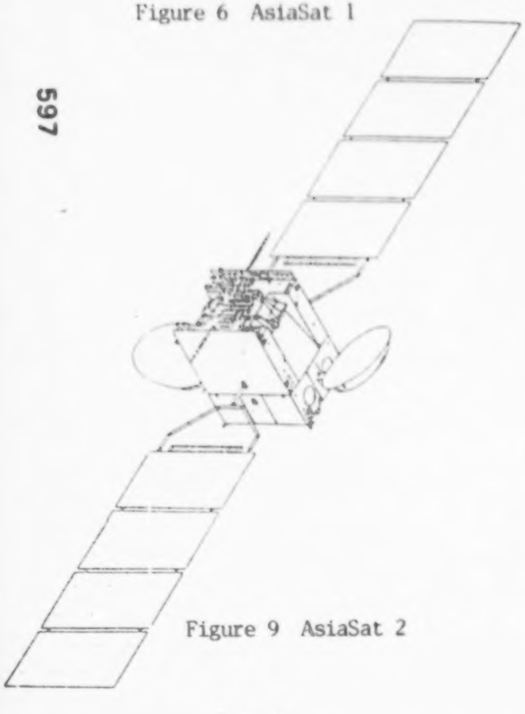


Figure 9 AsiaSat 2

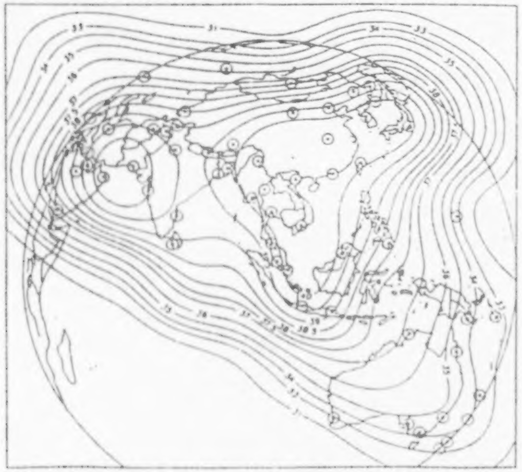


Figure 10 AsiaSat 2 C-Band Beams, EIRP

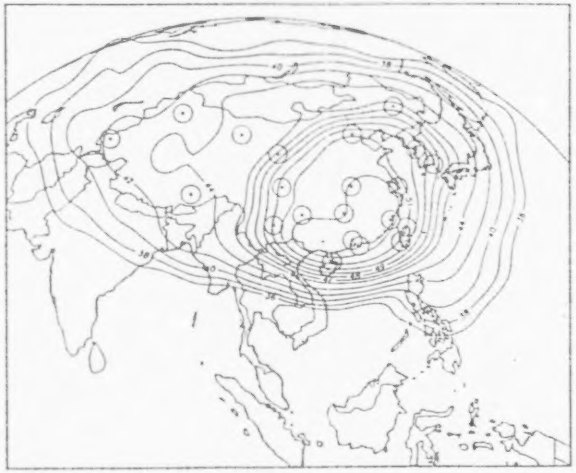


Figure 11 AsiaSat 2 Ku-Band Beams, EIRP

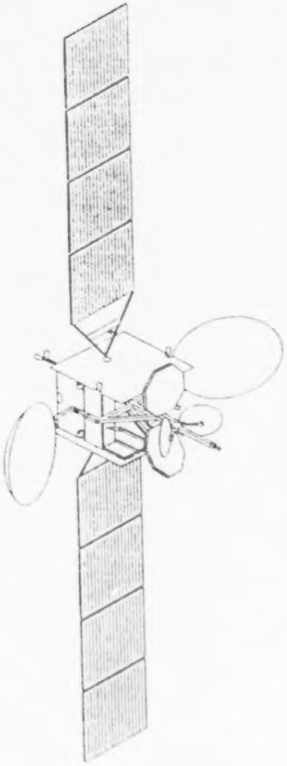


Figure 12 An Artist's Conception of AsiaSat 3

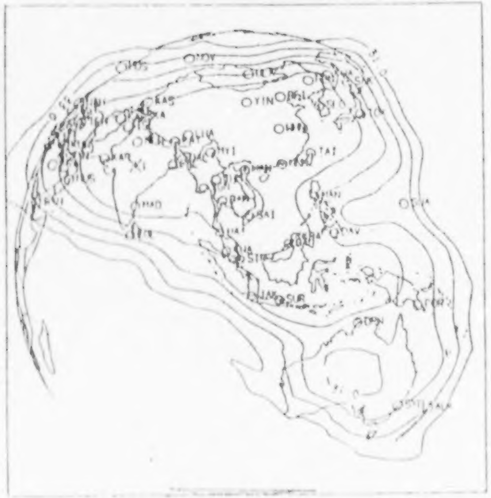


Figure 13 AsiaSat 3 C-Band Beams, EIRP

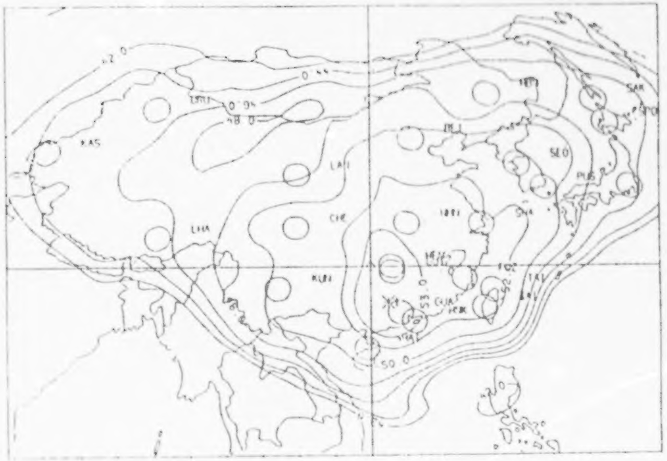


Figure 14 AsiaSat 3 Ku-Band China Beam, EIRP

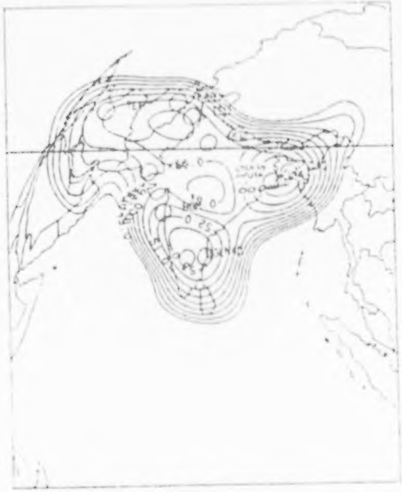


Figure 15 AsiaSat 3 Ku-Band India Beam, EIRP

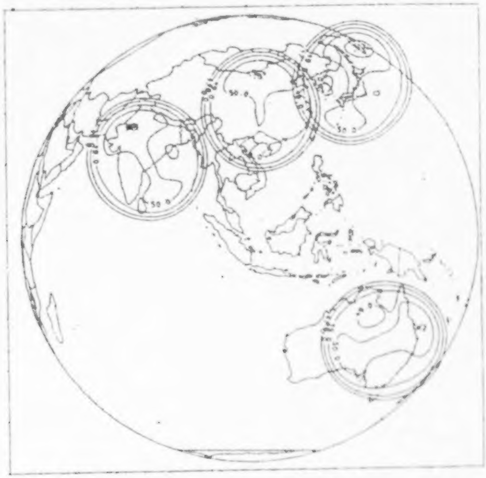


Figure 16 AsiaSat 3 Ku-Band Steerable Beam, EIRP

TRENDS AND APPLICATIONS OF SATELLITE OPERATIONS IN S.E. ASIA

ROGER NAFF
HUGHES SPACE AND COMMUNICATIONS INTERNATIONAL., INC.
LOS ANGELES, CALIFORNIA, U.S.A.

THIS PAPER WILL EXAMINE THE TRENDS IN SATELLITE APPLICATIONS IN SOUTHEAST ASIA AND THE IMPACT OF PRIVATE INVESTORS ON BUSINESS OPPORTUNITIES. ALSO THE CRITERIA IN THE SELECTION OF WHETHER TO BECOME AN OWNER/OPERATOR OF VALUE ADDED SERVICE PROVIDER IS EXPLORED

TRENDS IN SOUTHEAST ASIA SATELLITE SERVICES

Current research in the satellite industry shows two basic trends, both having a profound effect on the use and procurement of satellite systems. The first is a movement away from traditional governmental and institutional buyer/suppliers and toward entrepreneurs and second; the development of joint ventures between investors, users, operators and suppliers in the procurement and operation of satellite services.

The first trend represents a paradigm shift in the satellite business. The one time sole domain of governments; satellite purchase, definition of use, and operations have evolved to a creative breed of owner/operators with new and innovative uses for satellite transmission. For example, Astra in Luxembourg, ASC of India/Asia, Optus of Australia, AMT in Asia, and DIRECTV all represent nongovernmental satellite businesses. What these companies have in common is a commercial approach that offers satellite services for profit and goes beyond the transponder sale/lease model for satellite use. Each also offers new services to users, is applications driven, and represents a new way of doing business.

This shift has been accompanied by a trend in privatization and deregulation of the communications industry. Governments are finding it increasingly difficult to control and contain information access and content. They are discovering that the privatization and deregulation forces of the marketplace are outstripping their ability to control user demands. As a consequence some governmental and institutional bodies are attempting to "act as the new entrepreneurs" and adapt to these new trends as they; 1) represent a threat to existing business and 2) are also a new source of revenue. There are several examples of governments allowing concessions and forming partnerships with individual investors to run and operate satellites for profit.

Transponder Leasing Versus Value Added Applications

A second trend is a shift in how the satellite is being used. The mainstay of the satellite business has been the transponder lease and rental business. C-band leasing has been, and will continue to be, an important source of revenue for satellite operators in Asia in the immediate future. In the Southeast Asia region, most projections show current demand for leasing at 300 transponders. This represents a 90 transponder shortfall (excluding China and Japan). Demand is projected to increase to 400 transponders, but by the year 2005 growth rates will drop to a continued minimal 5% as the C-band systems on order today will catch up with existing transponder shortfall.

With lease rates now in excess of approximately U.S.$2 million per year for C-band transponders and U.S.$3 million for Ku-band, satellite lease operators can continue to operate a profitable business. However, as pointed out, the leasing businesses will come under pressure as satellites serving Southeast Asia continue to be launched. As a result, successful future leasing businesses will no longer be able to restrict themselves to traditional applications such as telecommunications. The successful lease business will evolve to serve a number of market that include:

- *Domestic telecommunications*—linking urban and rural regions in less developed countries with older infrastructures.
- *International telecommunications*—intraregional communications may be more viable as interregional service can be served by INTELSAT and/or submarine fiber.

- *Broadcast services*—governmental information services, distance learning, telemedicine and private programming television.

- *Business services*—private networks, two-way VSAT, Direct To Home TV (DTH) and video conference represent significant areas of growth.

While C-band transponder lease market may afford those with available transponder capacity a positive revenue stream the near term, future entrants and first time operators will be required to offer higher powered payloads capable of supporting multiple applications. This is especially important as availability of orbital slots become more acute.

Value Added Services And New Applications
Today plans for future satellite systems de-emphasize transponder leasing and emphasize value added services. Greater emphasis is being placed on higher level applications and value added services by the new entrepreneurs. Current business plans incorporate these new applications to differentiate operators from one another and to leverage higher level services to maximize revenues and increase profitability.

The trend is toward the creation of applications-based businesses rather than the traditional transponder lease/sale only operation. This is not to say that the transponder lease business is not, and will not, continue to be profitable. However, new businesses aimed at higher level applications and value added services offer less competition and higher profit margins for a new entrant than the more crowded lease market with several established suppliers.

Due to past concerns in heavy rain areas in Southeast Asia and the absence of today's Ku-band technology, the region has become dominated by C-band applications. With the development of digital compression and advances in spacecraft power, Ku-band based services are becoming more acceptable in Southeast Asia.

While the higher level services such as Direct To Home are attractive business ventures, they have a high cost of entry and require specialized staffing and operational experiences. For those willing to take the risks, profitable business cases exist for entering a single application market such as a mobile telephone system or regional Direct to Home TV.

Examples of Valued Added Applications include:
Mobile Communications. A cellular-like service with hand-held or vehicle fixed "phone" usually L-band. There are both GEO and MEO systems in operation or in development today.

Direct To Home TV. K-band and very small ground receivers, less than 60cm, allows for direct broadcast with specialized programming. Spacecraft antenna can be designed for specific coverage areas to focus or specific region(s) or maximize power requirements.

Distance Learning. This service combines several existing technologies; telecommunications, digital library, multi-media courseware, teleconferencing and Vsats. Can be interactive or broadcast service.

Tele-medicine. Investors are approaching telemedicine as a profitable future business. Benefits of tele-medicine include: cost effective and prompt medical attention, reducing national health care costs, eliminating travel costs for patients and others.

Virtual Vsat. Similar to land-line based virtual networks pioneered in the United States, these systems will allow data and voice switching. Users will no longer be tied to "bent pipe" transmission architectures.

Bandwidth of Demand. Onboard satellite digital processing and bandwidth on demand services are being planned for introduction in the next 2 to 5 years. These services will allow the end user to access the appropriate bandwidth required as defined by user applications.

Multi-media Applications. Closely related to bandwidth on demand services are multimedia applications. These services will allow combining of applications as if they were one.

Information Services. Will enable operators to send stock quotes, news headlines, sports scores, and eventually individual paging and message services. Information services and messaging are logical extensions of bandwidth on demand and multimedia applications.

OWNER/OPERATOR VERSUS VALUED ADDED SERVICE PROVIDE

In determining the business opportunity that represents the greatest revenue potential and quality of service, a decision must be made as operational objectives. The decision is whether to conduct business as an owner/operator leasing transponders or as a valued added service provider.

Owner/Operator

In this business the owner (or shared ownership) operates and supports a satellite system offering transponder capacity for rent or lease. There would be little responsibility for providing communications content or landing rights. Revenues would be derived from leasing and/or rental agreements from interested parties requiring satellite capacity.

Advantages of Owner/Operator

- Major start-up costs are limited to satellite, launch vehicle, insurance, ground station and ongoing support. Marketing requirements are limited to selling lease and rental capacity on transponders.

- The lease and rental business represents immediate revenue potential as demand for transponder capacity is currently running ahead of supply.

- Revenue stream requirements are straightforward and more easily determined.

Disadvantages of Owner/Operator

- Competition is widespread to include, but not limited to, Palapa, Optus, Measat, PanAmSat, Asiasat, and others entering the market.

- A new satellite operations would have to compete with others already in the same business. This may reduce profit margins as price becomes a major marketing tool to attract business.

- Because of its lower monetary requirements and lower operating costs than advanced services, the lease business makes it easier for others to enter the market.

- There is greater financial opportunity in valued added services. Entering the transponder "rental only" business may represent lost financial opportunity in the services market.

Value Added Service Provider

A service provider would enter into new businesses based on one or more satellite applications for the region. Depending upon the business venture, it is most likely that the operating company would be responsible for offering some type of content as part of a service offering. This new business is in addition to owning and operating a satellite system.

The important difference in becoming a service provider is that the satellite becomes the platform for a business venture. The satellite system is the means to an end, not the business itself, as with the owner/operator. The obviously important decision here is to determine what businesses represent the lowest risk, the greatest potential for success, and the least amount of competition.

Advantages of a Service Provider

- Financial and business returns can be very high.

- With fewer competitors and higher barriers of entry, future competition is less likely.

- Success in a major satellite venture increases the economic importance of country or company.

- Satellite systems increase influence in regional affairs.

- New businesses lead to other opportunities.

Disadvantages of Service Provider

- Start-up costs can be high depending on business selected. For example, a production studio for DTH-TV can cost in excess of U.S.$50 million.

- Marketing and distribution channels may require greater resources. Business relationships can become quite complex when operating DTH services in other countries.

- Revenue streams and billing services can be more complex.

- Business organization and structure is also more complex. Operating DTH services in other countries usually require in-country business partners as part of the operating organizational structure.

Service Provider And Owner/Operator

The option of entering the market as both an Owner/Operator and Value Added Service Provider is an option for some. The objective is to be flexible enough to take advantage of the existing market demand for transponder capacity short fall and offer value added services as new markets mature. This strategy allows immediate revenue flow in the existing leasing and rental market while developing the more complex, and more profitable, service businesses.

This approach combines a short term strategy of receiving immediate revenue from the rental market while implementing a long term strategy of capturing market share from higher revenue (and higher profit margin) businesses. As new value added services become more profitable and more in demand, leased transponders can be made available for the higher profit margin services.

Advantages of Service Provider and Owner/Operator

- Dual revenue streams based on short and long term strategies can help meet early investment requirements while more profitable long term service businesses mature.
- If major revenue producing value added services are an immediate success, short term transponder rental business can be quickly terminated and transponder capacity shifted to the new business.
- New services, no matter how well planned may experience some level of difficulty. If necessary, the less complex revenue stream of transponder leasing can be captured immediately as a business.

Disadvantages of Service Provider Owner/Operator

- Two dissimilar business units—one a transponder rental and lease entity, the other a complex value added business—would be more difficult to operate.
- Organizationally, there may be a lack of direction and focus as two businesses are put into place.
- The start-up costs for value added services can be high with returns very low in the first years when compared with the cost of entry. This can create a significant stress on cash flow.
- Not all applications, such as mobile systems, allow for operation as both Owner/Operator and Value Added Service Provider.

Marketing

Transforming a system into a business will depend on the development and execution of a well thought out marketing plan. Marketing will be a formidable factor in determining the success of the satellite business whether it be a lease operation or value added service.

There are several elements that make a successful marketing plan and in the end, a successful business. Understanding opportunity, customer issues, market drivers, and intangibles such as the social and political environment of the region will come into play.

While the demographics and demand curves for satellite business may be compelling, the execution of the overall business plan will determine the success of the venture. Once a system is properly designed and put into place, it will be up to the skills and commitment of the satellite company to determine success.

SUMMARY

Like other markets, the Asian market is forecasted to be made up of two general satellite business opportunities: 1) continuation of the transponder lease/rental business; and 2) more advanced applications and value added services.

As noted, there is an existing shortage of C- and Ku-band transponders. This trend is projected to continue to the year 2005 and then increase more slowly as more satellites are launched. C-band demand will continue to be important in providing telecommunications infrastructure and broadcast capability as countries build out their land-based systems.

Satellites represent a good near term solution as ground-based systems are expensive to operate and maintain, and they take considerable capital and time to put into place. Also, land-based systems may never be able to serve less populated areas or those with distinct geographic features such as found in Asia. As a result, existing service providers should continue to prosper in the near future.

In Southeast Asia satellite businesses the new entrant will be faced with several challenges. In addition to the areas covered in this paper, consideration must be given to competition from existing systems that have established customers, business practices, and a history of successful experience; and coordination of available orbital slots. Additional C-band systems will face problems with coordination of existing satellites. There may be more promise for high powered

Ku-band coordination as fewer systems are in operation. As technology continues to advance Ku-band and Ka-band are playing a more significant role in the region.

Today a company entering the Southeast Asia market should also carefully consider each strategy of entering the transponder leasing verses the value added higher level services. While the transponder lease business, especially in C-band, has fewer barriers to entry in terms of skills and initial investment; Direct To Home TV or other applications based on digital formats and Ku-band availability may provide greater returns.

Once the business opportunity is targeted, equally important care must be given to the organization and operational structure selected. If transponder leasing is deemed the best opportunity, then the decision is most likely to function as an Owner/Operator. However, if Value Added Service(s) is selected as the appropriate business the decision becomes more complex.

At issue is the decision to organized and operate as a platform provider, provider of content (pre-packaged or original) or as a "one-stop" Value Added Service Provider suppling satellite, content and perhaps landing rights. In the case of Direct To Home TV, functioning as a content provider may require operating a programming center.

A well developed business plan and selection of what appears to be the best operational structure does not insure success. The execution of the plan and marketing will be the final determining factors in the success of the business.

THE NEED FOR A MOBILE SATELLITE TERMINAL DESIGN IN DEVELOPING COUNTRIES: MEXICO'S EXPERIENCE WITH SOLIDARIDAD

Luis Tellez-Giron
REDSAT
Mexico

Abstract

The L Band is a scarce resource because it has premium advantages for handheld terminals. Global institutions like INMARSAT have taken advantage of this band providing different standards as A, B, C, M and mini M. Up to now, except for the in project new services D and P, the present services have resemblance with the maritme services that originated this global institution. The terrestrial usage of mobile global services have had poor and medium success market penetration for several reasons, except for Emergency, Military, Political and News Gathering systems, this penetration is even worst in developing countries.

Few countries have decided to establish a Domestic Mobile Satellite System: USA, Canada, Australia and Mexico. The priority for the 3 first developed countries has been a Dual Terminal Cellular-Satellite for voice communications, however it is not clear that for a developing country like Mexico it should be the priority. For Solidaridad Mexico's Hybrid Satellite System which includes a small capacity of L Band in bandwith and power compared with AMSC, TMI, and OPTUS systems, the experience has been "a solution in search of a problem". This paper explains why, and which data are valuable to give an idea of the important services to provide for developing countries using Mobile Satellite communications. Certainly it should not be a copy of INMARSAT or MSAT services as it is established at this moment.

There are two main conclusions for developing countries Mobile Satellite Services: 1)The services should include Entertainment/Music, Educational, News and/or Emergency Radio Broadcasting Channels and one Intelligent Transport/Security System supported by two way data channels and 2)There is a need to develope an Integrated Mobile Modular Unit (IMMU) together with a technological partner using or not already proven standard protocols from INMARSAT.

663

1.INTRODUCTION

During this decade there has been a substantial technological improvements in the Mobile Satellite Communications. The L band has been a very important key factor of this development, however is a scarce resource. Its advantages outperform the drawbacks for mobile satellite telecommunications. Some of the advantages are:

-The gain of the antenna could be as low as 0 dBi.

-The rain does not affect performance.

-It allows handheld units.

However, with this advantages the designer of the mobile satellite system has to consider that most of the L beams cover global areas and there is not much room for space segment room for Mobile Satellite Services (MSS) at present time. Most of the L band for MSS is already allocated among the present players which could be classified as:

* Geostationary Global:
    -MARISAT
    -INMARSAT A,B,C,M,
     Mini-M

* Radiodetermination
    -GPS
    -Glonass

*Domestic
    -USA
    -Canada
    -Australia
    -Mexico

*Radiobroadcast
    -CaribeStar
    -AfriStar
    -IndoStar

*Big LEOs USA

The way that each player has distributed the L Band pie is shown in Table 1. Due to lack of bands available for current MSS, after the WARC-2, there are some other opportunities in the L band, and an alternative band that is locatted at the S broadband, which is two times bigger than the L band; however, a very important issue here is that there is no plan al present time to introduce a system for Radiodetermination/locations service as GPS or Glonass at the S band, which is a very important complementary system to two-way data services like fleet management, emergency services or Where am I? services, very convenient with mobile people on the road.

2. GLOBAL VS REGIONAL / DOMESTIC MSS

The global systems up to now has been leaded by INMARSAT which as a world organization, it has taken advantage of prerogative access to PTT's, governmental institutions, big carriers and in general any monopoly o semimonopoly Telecommunications Institution. With this kind of organization the INMARSAT services have obtained certain sucess, mainly on nobody's territory i.e. international maritime territory and when the circumstances worth the usage of premium but expensive global services that cover most of the world territory, this means services mainly for News Gathering People (NGP), politicians, military, police, Indiana Jones people and lately for the organized crime as Cartel drug dealers, but definetely it is not adressed to regular enterprises or regular people like the John Smiths in USA, Juan Perez in Mexico or John Lees in Hawaii.

The INMARSAT organization can not claim also a sucess in the Land services arena mainly because of countries' domestic market protection and the mixed feelings of invasion of territory, fear loss of international revenues to entities outside their borders and bypass for domestic kind of communications. The partial success has been in the European Community with Inmarsat C terminals considering container fleet operations where is very common that containers transport goods between several European countries boundaries, something similar on mobile services voice and data will occur with the North American Free Trade Agreement (NAFTA) between Canada, USA and Mexico, but there are strong forecastings that this will be implemented using MSAT terminals.

On the other hand, all of the USA big LEO systems consider the main typical user as the Globetrotter

604

business traveler that could be a myth and a real failure if you question the real need of the business travel to use the same technology or terminal when he is abroad, and because the regulatory obstacles that this poor world business traveler could suffer tresspassing country regulations and customs at the airports, mainly in the European Community and developing countries. As was stated in a paper by Ed Slack COMSAT Director of Mobile Communications at Telecomm 95 Technology Forum in Geneva "No one questions whether regulatory change is needed in respect to the forthcomming mobile satellite communications battle. The issue is when and how it is to be accomplished, and whether or not the developing countries will be in control of the technology rather than the reverse" and I will add, if the European Community and the developing countries will be in control of the return investment (if any) or not. In this case, it is most likely that the Inmarsat P service will be the winner for both, the European community and the developing countries, just because the internationallity origin already given to this organization.

There are substantial different needs to solve for global and regional/domestic in MSS as is in Fixed Satellite Services, on the last, INTELSAT is focused to Broadcast Services, IBS, IDS and DAMA international voice services, meanwhile the regional/domestic services have solved besides regular Broadcast Services, cable and pay TV, TDMA large scale VSAT networks and SCPC voice/data channels, the same is going to be for Global or International MSS and Regional/Domestic MSS.

In domestic services, for example, is unacceptable to allow a call setup of 5 to 6 minutes from cold start as is right now the Inmarsat M call setup. The call set up for voice calls in mobile domestic services should be maximum as long as a regular cellular call, also the fleet management services should be more customized toward the region or national needs, considering for instance conections to insurance companies or local police. In other words the domestic mobile satellite services are not going to be as plain services, replacing on the portable side of the Plain Old Services (POS) like voice, data, fax (and next paging) services when no other better option is available, like INMARSAT (refer to table 2) and probably what most of the Big LEOs are trying to establish in the near future.

3. DEVELOPED VS DEVELOPING MSS

As in the previous section we can say that also, there are very different needs between developed and developing countries and the most important questions is : Is it worthwhile to develop specific MSS for developing countries?. Mexico is the first developing country that is facing this crossroad with an L band payload at its hybrid Solidaridad satellite system, and its decision unfourtunately has been to adopt mobile satellite systems already proved, due to the lack of mobile terminals in production in the market that really could satisfy Mexico's needs, and also because a bureaucrat kind of rush, trying to get results at the end of every governmental period.

The domestic MSS for developed countries, like the OPTUS for Australia and MSAT for Canada and USA, have been a confirmation of the Negroponte theorem which says that "over the next 20 years television and telephones as other services will swap their primary means of telecommunications". The main objective of developed MSS is to get a better coverage for cellular roaming using dual terminals (cellular/satellite). Even the Negroponte theorem could set the pace of telecommunications development in a country if you consider not only the main cities of the country, but most of the pupulation centers.As we observed in developing countries their main objetives are not following the same goals of the developed countries. The Negroponte Theorem modern telecommunications phenomenon is based upon the needs of capacity and mobility for developed countries which they already satisfied their primary needs and they are looking for secondary improvements of the stated "quality of life".

Of course, it is not the case for developing countries which they are looking to solve some other primary needs, but the mistake that frequently the developings countries have incurred, instead of leapfroging with the technology and adapt some solutions to their problems, they find out a technological solution in search of a problem, arguing that they have to follow standards already given in the world, and take advantages of production volumes and economies of scale. This has been the Mexico's experience for MSS in Solidaridad looking for a problem to solve like: rural telephony, military or governmental institutions communications as main targets.

In order to introduce a successful product or service, one of the key marketing laws is look for volume as profitable as possible, very simple but hard to find and implement. For domestic MSS there is no relation with the size of the country , population density, or population isolation; there are two factors more important than those: Percentage of rural population and GNP/capita; countries like Canada, USA and Australia which are already decided to go for a domestic MSS are strong on both, however developing countries could score high on percentage of rural population, but their GNP/capita are frequently one order of magnitude significantly less than developed countries, see Figure 1 as an example with Latin american countries; furthermore for cellular/satellite roaming what is most important probably is the amount of total vehicles or vehicules/capita in the country in which by far USA is an outstanding performer if you compare with any other country (developed or developing) in the world (Figure 2). Of course these amount of vehicles could guarantee a success of the MSAT and other MSS systems in USA, as well.

According with a study performed by us, the developing countries like Mexico are good candidates for domestic MSS if these services help to solve issues like:

-Information/entertainment coverage.

-Security and crime stoppers.

-Emergency against natural disasters.

-Information that promotes national or international tourism.

-Essential an cheap communications between the Rural and non Rural communities etc.

One of the non essential and non cheap communications in the rural communities for developing countries is the myth of Rural Telephony, this myth could be a big question mark as it is the International Bussines Traveler for the Global MSS. Although the Rural Telephony for developing countries is a real and unsolved problem, that even organizations like Teledesic pretends to address this world problem using Star Wars technology together with the broader Ka Band, I personally do not think that being the L Band so scarse and the prices of services and terminal in the L band definetely not in the low range , that this could be a solution for a problem that you could have wondered. Where do the rural people form the developing countries call? main reasons to call? (they have lived without the real need for centuries), Is there another cheaper alternative for real needs that really improves the quality of life at rural communities?, like a bidirectional pager data service for medical emergencies, agricultural prices, money orders payment etc.. Also the experience have shown in rural telephony for public phones that the main enemy is, unfourtunately, the vandalism performed by the rural population, something very different if the service is personal or private (like Teledesic approach) or it is an access controled system like the payment of money orders.

4. MSS PROPOSAL FOR DEVELOPING COUNTRIES

Mexico, as one of the first developing countries to enter to the MSS, it has been very conservative and careful considering standards and terminals in the market for the L band , however this decision has set up several obstacles during three years since the conception, and two years since the launch of the first Solidaridad satellite. At this moment, there is no commercial domestic L band service available from Solidaridad and no domestic land L band services allowed from INMARSAT because of market protection to the Mexican Satellite.

The services planned by Telecomm Mexico using the Solidaridad L band are (1):

a)Movisat-Datos: Inmarsat C kind of services for 600 bps store & forward data, for 6,000 estimated market and a possible extension of 10,000 terminals.

b)Movisat-Voz:Cellular and Satellite services with AMSC standards and Westinghouse or Mitsubishi terminals, 1.50 dlls planned rate per minute call. Estimated market for 50,000 users compatible with USA and Canada MSAT services.

c)Rural telephony for 20,000 rural towns with less than 500 inhabitants. Costs of 4,000 dlls terminals and an estimated rate (most likely subsidized tariff) of 0.70 dlls per minute. This system could be using Inmarsat M or Mini-M technology.

The main problems that Mexico has encountered on this conservative plan have been.

Standars: Trying to follow standars for a domestic service in L band, where the L band is already running out of space segments in the world. The main idea of Mexico is to use domestic services with AMSC and INMARSAT that allow the perfect combination and the best of both worlds even using a kind of roaming activities for North America Region (AMSC standars) and for Global (INMARSAT), this kind of combination has not been easy to solve and have been delaying many decisions on the way. It could be argued that if the L is running out, there is no sense following standards, if your L band payload is already in place and ready to work domestically.

Frequencies: Again as the L band is a scarse resource, the battle to get frequencies is tough and delays service operations, specially if you are using the technology of the players you are figthing against like TMI, AMSC and INMARSAT.

Terminals: Eventhough Mexico chose the way to get better chances of terminal availability, it has been diffficult to reach this goal. In the INMARSAT- C case , the standard followed by Mexico for the MOVISAT-data service, there are more than 20 suppliers in the world, however not all of them fit into the system "customized" by the LES vendor, taking in consideration that it is also involved in terminals marketing strategy at both systems AMSC and INMARSAT. The "customization" had to be accomplished because of an adaptation of L band frecuencies for Solidaridad, power for the system and translation of frecuencies from C-Band (feeder link for INMARSAT) to Ku-Band (feeder link for Solidaridad). For the MOVISAT-voice service the AMSC was selected and in this case, at present time there are only two licensed suppliers Westinghouse and Mitsubishi, but their main interest are to supply in a rush primarily for the US market, and secondly for the Canadian market, the Mexican market of course is not a priority for them.

These experiences tell us that the developing countries can not rely on Global standards or domestic Standards for developed countries in MSS. The capacity is also a very important issue, at table 3, it is shown the capacities limits if you consider the Solidaridad system with 46 dBw EIRP, L band bandwith of 4.3 Mhz (this is what Mexico could get at the frequency battle) and voice activation of 0.4 ratio. As you can observe both the AMSC or INMARSAT services are either power or bandwith consumers. There is a need, for the developing world to solve many problems for mobile, semifixed or rural users, mainly with litle bandwith consumption, the voice services like the AMSC and INMARSAT M or mini-M are not a clear requirement for the regular user in the developing countries, and besides they consume a lot of power or bandwith.

Base upon, the needs and a market research study described and performed by my company in Mexico, I would like to adress a sketch of a proposal of MSS for developing countries. It is very likely that these services should be adapted and polished for every country, but at least I think that a "bare bones" approach can be described considering the Mexico's experience.

The results of our market study in Mexico, (2) could be summarized by the following statements.

-98% of the population has AM-FM radio but the territory coverage is only 50% or less.

-47% of households have at least one vehicle and 90% of them have AM-FM radio.

-Listening AM-FM radio is the second entertainment (62%) after TV(76%), not too much difference.

-94% of the population mentioned the broadcast radio very important for emergencies.

-90% of the population thinks is the

667

best and most credible media to get information.

-47% of the population has a vehicle and is captive between 1 to 3 hours daily, 45% of them listening radio broadcasts the same amount of hours.

-72 % of the vehicles have some kind of alarm integrated and only 13% of the vehicles have cellular phone (considering also handheld units not integrated at the vehicle).

-89% of the cellular users are happy with the present terrestrial coverage.

-67% of the population that have a car would be interested in a unit that could have Digital Audio Broadcast (DAB), two way pager services and an alarm which indicates where is the car located.

On the last point, the amount of interest to buy a Mobile Satellite terminal that ranges between 1,000 to 3,000 dlls by a common user are as importance of order:

-Thief alarm connected to Insurance companies (not many expressed the need to be connected to the police or voted against it).

-Payed Music (no need for CD quality, but selected music channels).

-Solve emergency situations in general.

-Inmediate information about traffic or problems at highways.

-Bidirectional pager services (mobile to pager could be using short canned or standard messages).

-Roaming with dual units.

From our study, the common mobile user (not considering fixed or semifixed rural users):

-She/He is afraid about her/his security on the way.

-She/he lives more in the car than in USA but less than Japan.

-She/he desires to receive and provide more information on the way.

-She/He listens more AM-FM radio than USA but with less coverage.

5.NEED FOR AN INTEGRATED MOBILE MODULAR UNIT (IMMU)

The main thesis of this paper is that there is an important market in developing countries for a satellite mobile unit if this unit complies with the following as main services (3):

Emergency channels

-Systems to avoid or prevent vehicle robbery.

-Systems to recover stolen vehicles.

-Systems to avoid or prevent assaults.

-Channels dedicate to receive information broadcasts about emergency situations (Data and/or Voice).

Music/Information channels

-Selected Music.

-News channel.

-Telemarketing.

-Poll answering.

Intelligent Transport System

-Two-way messaging system.

-Conection to nation-wide pagers system.

-Vehicle tracking.

-Fleet management.

An Integrated Mobile Modular Unit (IMMU) could be a scalable solution to provide all range of services depending of the needs and price to the user. the prices could range from 200-300 dlls for basic services and from 1,000 - 3,000 dlls por specialized or premium services for payed music. positioning systems. CD ROM and CD-music. and Electronic Digitized Maps. The manufacturing of the IMMU should be at two levels. the basic module level with a technological partner. like the PC's. and specialized integrators/manufacturers for the end user units version. these integrators/manufacturers could be licensed by the service provider or not. depending of the grade of control that the service provider wants to have.

The advantages of an IMMU are:

-Improves the bandwith usage of current MSS.

-A search of a technological partner that provides a basic module. avoids the conflict to be captive by terminal manufacturers.

-Major market penetration.

-Multipurpose units.

-Avoid expensive and/or plain services that do not solve real problems/needs.

The disadvantages of an IMMU could be:

-Takes time to design and implement. at least two years.

-At the beginning it is not an international standart. but could be in the future.

-The market growth will depend mainly by vehicle manufacturers that sell the IMMU as an optional device.

It is worthwile to mention that there has been some trials on the market of this units like a radio-cassete player integrated with some GPS functions from DELCO. and also some designs of the complete system that have been left on the drawing board. like the RADIOSAT system by Gary Noreen (4). proposed to be implemented at AMSC system. but the lack of interest from Cellular service providers in USA -a developed country-. have left no opportunity for this kind of services and ideas that could be ideal for developing countries. It is also important the efforts that have been designed from the Little LEOS. and from DAB systems like Indostar. Caribestar and Afristar that are leading at this moment. the way of MSS for developing countries.

6. CONCLUSIONS

Usage of present INMARSAT or INMARSAT like services does not solve some important needs of MSS for developing countries. mainly if a massive manufacture of a mobile satellite terminal means economies of scale toward an unexpensive terminal as one main objective. nor a copy of present domestic (MSAT and OPTUS) or LEOS. using the L band. conceived at this moment: of course that is a big market detected for all them. no matter if is an user from a developed. developing or undeveloped country. but they are not addressing directly the market for developing countries. nor satisfing completely their problems and their needs. The commercial MSS conceived up to now are either very plain/flat or very sofisticated for the real needs of the developing countries. considering also the cost of the terminals. Probably the systems that have approached more the developing countries market have been the Indostar. Caribestar. Afristar Radiobroadcasting systems. and the small LEOS but they are not modular or integrate simple and value added services in one upgradable terminal approach.

We describe here a more likely system and terminals that really solve problems and needs for developing countries. and not the other way around like Mexico is doing at this time "a terminal/system solution in search of a problem". probably because of lack of alternatives in the present market. There is no excuse statement - technology to be developed- in the MSS arena. The technology is already there considering the Radiodetermination. Radio Broadcast and Two way Data Satellite developments in this decade. The bigger problem to solve probably is to find a Mobile Satellite Band with

Radiodetermination (GPS, GLONASS, etc) already in place or to be launch.

What it seems clear, is that it is needed to considered an Integrated Mobile Modular Unit (IMMU) for developing countries together with a Technological partner using or not mobile satellite standard already in practice in developed countries.

ABOUT THE AUTHOR

Luis Tellez-Giron has experience on Telecommunications in Data, Satellite and Radio Communications fields. Work experience with TRANSDATA as designer of Data Communications Equipment, ITSA and Arthur D. Little as Sr. Telecommunication Consultant, Assistant Vicepresident for TELEVISA and Resident Vicepresident for CITIBANK Sucursal in Mexico N.A. ; at present time he is Vicepresident of Engineering for REDSAT and Meissa Telecommunications Inc.. He received his Bachelors on Electrical and Communications Engineering at Universidad Iberoamericana Mexico City, 1977 and Master of Science Electrical Engineering degree at the University of Hawaii, Manoa Campus, 1980.

REFERENCES

(1) Resumen de Ley Federal de Telecomunicaciones Revista Voz y Datos 4 trimestre de 95. pp 20.

(2) Estudio de Mercado sobre el lanzamiento de un nuevo radio especial para automovil. Sept. 1993. Investigacion Estadistica y Demografica S.A. de C.V.

(3) Plan de Negocios para Comunicaciones Móviles por el Sistema de Satelites Solidaridad. Nov. 1993 Redes Via Satelite S.A. de C.V.

(4) Radio Satellite Corporation. Business Plan. Nov. 1991. Gary Noreen.

Table 1. L Band Frequencies. Region 2

SYSTEM	SAT = >Mov	Mov = >Sat
Inmarsat A	1535-1543.5	1635.5-1645
Inmarsat C	1530-1545	1626.5-1646.5
Inmarsat M/B	1525-1559	1626.5-1660.5
GPS	1575.42	
Glonass	1616	
AMSC	1545-1559	1646.5-1660.5
Solidaridad	1525-1530	1626.5-1631.5
LEOS USA	2483-2500	1616.5-1626.5
DAB	1452-1492	

Table 2. L Band Geostationary Global

Characteristics	Inm-A	Inm-C	Inm-M	Inm-B
Type	Analog	Digital	Digital	Digital
Introduction	1976	1989	1992	1993
Voice	FM	....	4.8 Kbps	16 Kbps
Data	56 kbps	600 bps	2.4 Kbps	16 Kbps
Fax	FM	....	2.4 Kbps	9.6 Kbps

Table 3. Growth Limits for Solidaridad

System	MSAT Contou.	MSAT High Gain	MSAT Fixed	INMAR. M	INMAR. M Fijo	INMAR. Mini-M
BW/channel	6 KHz	6 KHz	6 KHz	7.5 KHz	7.5 KHz	5 KHz
Power/channel	30.5 dBw	27.5 dBw	18 dBw	17 dBw	12 dBW	23 dBw
# power limit	89	177	1577	1986	6280	424
# BW limit	716	716	716	573	573	860
# real limit	89	177	716	573	573	424

Figure 1.Domestic. Two Basic Data for MSS Voice

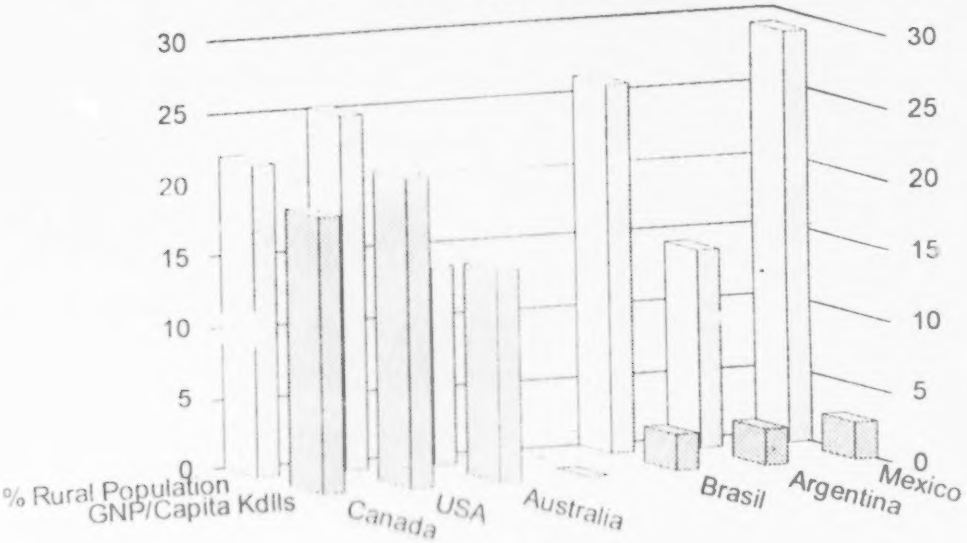
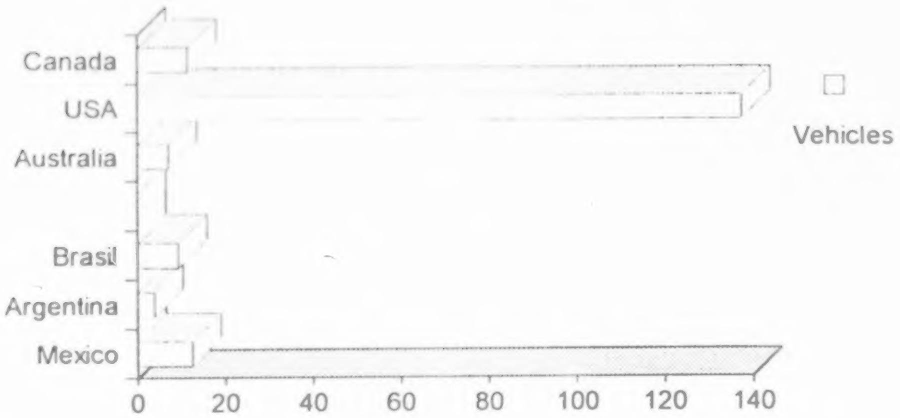


Figure 2.Domestic. Guarantee for Volume "Roaming"



The Move to Ka-Band Satellite Telecommunications-
An Assessment of Services, Availability and Performance

Dr. Louis J. Ippolito
ACS, *a division of* Stanford Telecom
Reston, Virginia, USA

ABSTRACT

The Ka-band, consisting of uplinks at around 30 GHz, and downlinks around 20 GHz, is the next higher band, above C-band and Ku-band, allocated by the International Telecommunications Union (ITU) for fixed, mobile, and other satellite services. This paper describes the systems being proposed for the Ka-band, and reviews the advantages and disadvantages of operation in the band. Regulatory issues, including potential sharing problems with terrestrial services, are described. Unique considerations for the Pacific rim region, particularly the effects of tropical rains on system performance, are discussed. The paper concludes with an assessment of the impact of Ka-band systems on telecommunications services into the next century.

1. INTRODUCTION

The communications industry has recently seen a vast increase in interest in the use of the Ka-band portion of the radio frequency spectrum for the provision of new and innovative satellite based telecommunications services. The Ka-band, consisting of uplinks at around 30 GHz, and downlinks at around 20 GHz, is the next higher band, above C-band and Ku-band, allocated by the ITU for fixed and mobile services. Advantages of Ka-band operation include: increased bandwidth and data handling capacity; reduced size of components, especially antennas; and the ability to provide narrow spot beams to the ground, allowing for extensive frequency reuse and efficient use of the radio spectrum. Ka-band links, however, can suffer from serious degradations in performance during rain or other weather conditions, and systems designed for operation in the band must take into account the effects of the atmosphere.

2. Ka-BAND SYSTEMS

The history of satellite communications in the Ka-band (27-31 GHz uplink / 17.7-21.2 GHz downlink) began with the introduction of beacon measurements in the 1970's to characterize propagation effects, primarily rain, with NASA Applications Technology Satellites, ATS-5, ATS-6, COMSTAR (USA), ETS-II (Japan), SIRIO (Italy), CS (Japan), and OTS (European Space Agency, ESA). Operational Ka-band communications links were introduced by Japan on the CS satellites, followed by ESA's Olympus (1989), Italy's ITALSAT F1 (1990), and most recently, NASA's Advanced Communications Technology Satellite, ACTS, launched in September 1993.

There are a wide array of satellite based telecommunications systems and applications in the advanced planning stages slated for Ka-band operation. Most of these systems capitalize on the benefits of Ka-band operation to provide 'bandwidth on demand' to small fixed or mobile user terminals. Ka-band satellite based systems fall into three general areas, each described briefly below.

Geostationary Orbit Fixed Satellite Service (GSO/FSS) Systems This area involves the extension of traditional domestic and international fixed service (FSS) systems utilizing small VSAT terminals and geostationary satellite orbits. Ka-band systems offer the advantage of small antenna size (0.6 meters typical) and high data rate (T1 and higher). Systems of this type include NorStar, proposed by Norris Satellite Communications, Inc.; Spaceway, from Hughes Communications Inc., (recently renamed Galaxy/Spaceway); and CyberStar, from Loral. The United States Federal Communications Commission (FCC) recently requested comments for Ka-band services [1], and in September 1995 announced fifteen applications as acceptable for filing.

Additional organizations submitting Ka-band applications at that time for GSO/FSS service, listed along with their system name if specified, include: AT&T (VoiceSpan); Comm, Inc., a division of Motorola (Millenium); EchoStar Satellite Corporation (EchoStar); GE Americom (GE*Star); KaStar Comm. Corp. (KaStar); Lockheed Martin (Astrolink); Morning Star Satellite Co.; NetSat 28; Orion Network Systems (Orion); Panamsat Corp. (PAS-10,11); and VisionStar, Inc. (VisionStar). The total number of GSO satellites proposed for Ka-band FSS operation by the above listed systems exceeds 72, in 56 orbital slots!

Non-geostationary Orbit Fixed Satellite Service (NGSO/FSS) Systems A major new development in satellite based telecommunications has been the proposed introduction of non-geostationary satellite orbit (NGSO) systems before the end of this century. One of these proposed systems, Teledesic, plans FSS operation with service links in the Ka-band. The Teledesic system, operating with an 840 satellite circular low earth orbit (LEO) constellation, is a project of McCaw Cellular Communications and Microsoft Corporation. The Teledesic system provides 16 kbps to T1 rates operating with a 10 inch (25 cm) user antenna. An addendum to their original application to the FCC provides for the addition mobile satellite services to the Teledesic system architecture.

NGSO Mobile Satellite Service (NGSO/MSS) Feeder Links At least three of the proposed NGSO mobile satellite service systems, Iridium, Odessey and AMSC, are considering the Ka-band for the provision of feeder links for their networks. The Ka-band offers a wider bandwidth over C-band or Ka-band, however sharing issues with the other proposed services is a concern.

Other services are also under consideration for the Ka-bands. NASA is considering the band 23-26 GHz for its next generation space-to-ground links for its Tracking and Data Relay Satellites, which currently operate in the 15 GHz band.

The 28 GHz band has also been proposed for a new terrestrial service, called local multipoint distribution service (LMDS) in the United States. LMDS, operates with a cellular architecture consisting of hub transmitters radiating to small consumer terminals. Both one-way broadcast entertainment video and two-way interactive data services could be provided. Initial systems would be analog video, with later systems providing digital video and two-way data services.

3. ADVANTAGES OF Ka-BAND OPERATION

Satellite communication in the Ka-band offer advantages over C-band and Ku-band systems. They include:

Increased Bandwidth and Data Handling Capacity The Ka-band offers additional frequency and data handling capacity for space and terrestrial applications. Most Radio Frequency (RF) components can operate over a specific percentage range of frequency or percentage bandwidth. Ka-band RF frequencies are a factor of about 2 higher than for Ku-band, and a factor of 5 higher than for C-band. Therefore, for amplifiers and other devices with a 10 percent operating range, Ka band offers 2000 to 3000 MHz of information bandwidth, versus 1200 to 1400 MHz at Ku-band, and 400 to 600 MHz at C-band. Ka-band offers a solution to spectrum shortage problems currently being felt in the C-band and Ku-band. New and innovative services, involving fixed, mobile, video, and high data rates, can use the wide spectrum available in the Ka-band. HDTV and multi-media applications need bandwidth, and the Ka-band, with 3.5 GHz of spectrum allocated for space services, is a logical next step in the development of satellite based telecommunications services.

Reduced Component Size Another benefit of the higher operating frequencies of Ka-band is the reduced size of RF components that are required. The smaller wavelengths of the Ka-band requires smaller antennas, filters, and waveguide structures to obtain comparable performance to Ku-band and C-band systems of much larger size. Ka-band VSAT antenna sizes as small as 0.25 to 0.6 meters can provide the same services as 1.2 to 2.4 meter systems at Ku-band and 3.2 to 4.5 meter systems at C-

674

band. Ka-band systems offer the promise of better customer acceptance, since the size of the antenna system has been a major factor in determining the success of satellite based telecommunications systems for the home or office.

Small Satellite Footprints The same factors that result in smaller component size at the Ka-band allows for the ability to provide higher gain antennas on the satellite for reasonably sized antenna reflectors. This results in higher Effective Isotropic Radiated Power, EIRP, and reduces the size of the satellite antenna beamwidth or footprint on the surface of the earth. Ka-band systems can utilize multi-beam architectures which allow for extensive frequency reuse and thereby offer highly efficient use of the radio spectrum. Spot beams of Ka-band systems can be as small as a single metropolitan area (50-100 km^2), and frequency reuse factors of 40 or higher have been proposed. These characteristics are not feasible at lower frequencies, where the satellite antenna would have to be unacceptably large to meet the gain and beamwidth requirements.

4. DISADVANTAGES OF Ka-BAND

The effects of the earth's atmosphere on satellite communications links is a constant concern in the design and performance of space communications systems. The problems become more acute for systems operating in the bands above 10 GHz. The major factors affecting earth-space links in the Ka-band are:

- o gaseous attenuation,
- o rain attenuation,
- o depolarization,
- o radio noise, and
- o tropospheric scintillation.

These conditions, when present alone or in combination on the link, can cause variations in signal amplitude, phase, polarization, and angle of arrival, which result in a reduction in the quality of analog transmissions and an increase in error rate for digital transmissions.

Gaseous Attenuation Even apparent clear sky conditions can produce propagation effects which can degrade or change characteristics of the transmitted radiowave. Gasses present in the earth's atmosphere, particularly oxygen and water vapor, interact with the radiowave and reduce the signal amplitude by an absorption process. Turbulence or rapid temperature variations in the transmission path can cause amplitude and phase scintillation or depolarize the wave. Clouds, fog, dirt, sand, and even severe air pollution can cause observable propagation effects. Background sky noise will always be present, and contributes directly to the noise performance of the communications receiver system.

Rain Attenuation Rain attenuation, by far the most serious degradation which can effect reliable communications in the Ka-band, results in a reduction in signal amplitude caused by hydrometeors (rain, clouds, fog, snow, ice) in the transmission path. Rain attenuation can produce major impairments in space communications, particularly in the frequency bands above 10 GHz. Cloud attenuation and fog attenuation are much less severe than rain attenuation, however they must be considered for low margins systems or systems operating with low elevation angles. Dry snow and ice particle attenuation is usually so low that it is unobservable on space communications links operating in the Ka-band.

Depolarization Depolarization refers to the change in the polarization characteristics of a radiowave caused by a) hydrometeors, primarily rain or ice particles, and b) multipath propagation. A depolarized radiowave will have its polarization state altered such that power is transferred from the desired polarization to the other polarized state, resulting in interference or crosstalk between the channels. Rain and ice depolarization can be a problem particularly for frequency reuse communications links which employ dual independent orthogonal polarized channels in the same frequency band to increase channel capacity. Multipath depolarization is generally limited to very low elevation angle space communications, and will be dependent on the polarization characteristics of the receiving antenna.

Radio Noise is the term used to describe the presence of undesired signals or power in the frequency band of a communications link, caused by natural or man-made sources. Radio noise can degrade the noise characteristics of receiver systems and affect antenna design or system performance. The primary natural noise sources in the Ka-band are the SAME effects which cause attenuation: atmospheric gases (oxygen and water vapor), rain, clouds, and surface emissions. Man-made sources include: other space or terrestrial communications links, electrical equipment, and radar systems. (Extraterrestrial cosmic noise must only be considered for frequencies below about 1 GHz.)

Tropospheric Scintillation Scintillation refers to rapid fluctuations of the amplitude and the phase of a radiowave caused by small-scale irregularities in the transmission path (or paths) with time. The terms ***fading*** and ***scintillation*** are often used interchangeably, however fading is usually used to describe slower time variations, on the order of seconds or minutes, while scintillation refers to more rapid variations, i.e., fractions of a second in duration. Tropospheric scintillation is a problem in the Ka-band for very low (< 5-10°) elevation angle systems operating in humid hot weather conditions.

Extensive experimental research has been performed on the direct measurement of all of the above propagation effects on earth-space paths, beginning in the late 1960's, with the availability of propagation beacons. Concise modeling and prediction procedures for the above propagation factors, based on data and measurements from satellite beacons, have evolved over several iterations and have been successfully applied in the design and performance of satellite telecommunications systems for several years [2]. The results of these activities have demonstrated that acceptable service availabilities can be provided for a wide range of applications in the Ka-band, and have been demonstrated by the experimental and operational Ka-band links already in service.

5. REGULATORY ISSUES

The Ka-bands allocated for space applications, as with most bands in the radiowave spectrum, contain other space and terrestrial applications allocations which must co-share the frequencies, either on a primary or secondary basis. The 17.7 GHz - 21.2 GHz band, allocated for downlink Fixed Satellite Service (FSS), contains several sub-bands with other primary space and terrestrial applications (see Figure 1). The only sub-bands with an exclusive FSS downlink primary SPACE allocation in all three ITU regions are the 18.1-18.6 GHz and 18.8-19.7 GHz bands [3]. A similar situation exists within the 27-31 GHz FSS uplink band (see Figure 2). Only the 27.5 - 29.5 GHz band has an exclusive primary FSS downlink SPACE allocation in all three ITU regions [4].

The large number of space and terrestrial applications wishing to operate in the Ka-band has led to several regulatory battles over the spectrum. The FCC recently issued a proposed band segmentation plan [5] which divides up the 27.5 to 30 GHz band between satellite services, (geostationary and non-geostationary FSS, MSS feeder links), and local multipoint distribution service (LMDS), a wireless terrestrial video distribution service (see Figure 3). The FCC did not consider the satellite proponent request to allocate LMDS in the 41.5-43.5 GHz band, where LMDS is located in Europe and elsewhere. The segmentation plan is the latest element of a rulemaking process which began in 1992 in response to LMDS proponents to operate in the band currently allocated to other space and terrestrial services.

The spectrum auction issue is also important in developments at Ka-band. The FCC has said it would consider auctions in the case of FSS and LMDS incompatibilities, however it stated that MSS feeder links allocations will not be auctioned. Currently, Teledesic is the sole proposer of non-geostationary orbit FSS in the Ka-band.

The LMDS sharing issue and spectrum auctioning were two of the reasons that led a group of fourteen satellite companies to form a new trade association in July 1995 called the Satellite Industry Association, SIA. The SIA was created to present a unified position on several key regulatory and allocation issues facing the satellite industry in the international arena. The Ka-band sharing issue and spectrum auctioning were two of the major areas addressed by the SIA in its initial activities. Members of the SIA include major U.S. satellite manufacturers and launch providers, and international organizations such as Arianspace and PanAmSat.

6. Ka-BAND AND THE PACIFIC REGION

The Pacific region has a wide range of weather conditions, including areas which can impact Ka-band performance in significant ways. Sub-tropical and tropical regions have more severe rain conditions than temperate maritime or continental regions. The Pacific region offers a diverse range of weather conditions, and an assessment of the potential effects of rain on typical satellite links can be useful in assessing the relative impact of rain on systems operating in the Ka-band.

Most of the Pacific is currently utilizing C-band and Ku-band satellite systems, and the expected performance of Ka-band systems, as compared to Ku-band systems, was determined by application of the Global Rain Attenuation Prediction Model [6].

Figure 4 summarizes the results of this analysis for three representative climate regions in the Pacific rim area. The exhibit tabulates the required rain margins for Ka-band systems and compares them with rain margins at Ku-band for the same link conditions. A 35^0 elevation angle was assumed for all links.
Two link availabilities are listed, 99.5%, and 99%, corresponding to a representative range of typical VSAT systems. The values in parentheses under each of the Ka-band margins represent the differential attenuation with respect to a Ku-band link operating at the same location, under the same link conditions. It is interesting to note that the differential attenuation for the downlink, usually the most critical for VSAT systems, is only about 1 to 2 dB higher at Ka-band, except for the 99.5% link in the Tropical region. These differential values, while not insignificant, are not insurmountable. Additional gain is available at the higher frequencies for the same size antenna aperture, and other techniques, such as spot beams, adaptive rain compensation (such as demonstrated on ACTS), and site diversity are available to the system designer.

7. SUMMARY AND ASSESSMENT

This paper has provided an overview of satellite systems proposed for the Ka-band, for fixed services, mobile services, feeder links and other applications. The Ka-band offers significantly increased data handling capacity, with 3.5 GHz of spectrum available for satellite and other applications. Critical drawbacks to Ka-band operation are caused, for the most part, by adverse weather conditions along the path, primarily rain attenuation. Several regulatory and frequency allocation issues involving Ka-band satellite and terrestrial systems are currently in the spotlight, and extensive activities in the international frequency allocation process are ongoing.

An evaluation of Ka-band links for Pacific region locations has shown that the differential performance, when compared with Ku-band systems, is within acceptable limits, allowing for system design options to provide Ka-band systems with similar levels of link performance to that currently experienced at Ku-band. The introduction of Ka-band systems in the next decade offers major increases in capabilities and performance to the satellite user, and these benefits can be expected throughout the Pacific region.

8. REFERENCES

[1] Federal Communications Commission, SPB-20, DA 95-1689, released July 28, 1995.

[2] see for example, ***Radiowave Propagation in Satellite Communications***, Louis J. Ippolito , Van Nostrand-Reinhold, New York, 1986.

[3] The FSS still must share with the Fixed and Mobile Terrestrial Services on a coprimary basis in these bands.

[4] The FSS still must share with the Fixed and Mobile Terrestrial Services on a coprimary basis in this band.

[5] Federal Communications Commission, Common Carrier Docket No. 92-297, July 13, 1995.

[6] R.K. Crane, "Prediction of Attenuation By Rain," *IEEE Trans. on Communications*, Sept. 1980.

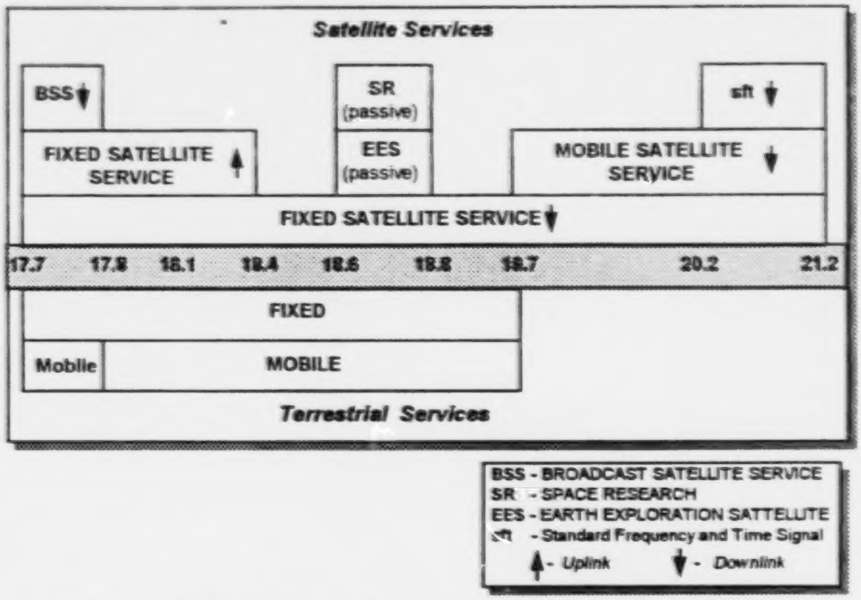

Satellite Services
BSS
SR (passive)
sft
FIXED SATELLITE SERVICE
EES (passive)
MOBILE SATELLITE SERVICE
FIXED SATELLITE SERVICE
17.7
17.8
18.1
18.4
18.6
18.8
19.7
20.2
21.2
FIXED
Mobile
MOBILE
Terrestrial Services
BSS - BROADCAST SATELLITE SERVICE
SR - SPACE RESEARCH
EES - EARTH EXPLORATION SATTELLITE
sft - Standard Frequency and Time Signal
- Uplink
- Downlink

Figure 1. Ka-Band Downlink Frequency Allocations, ITU-R Region 2.

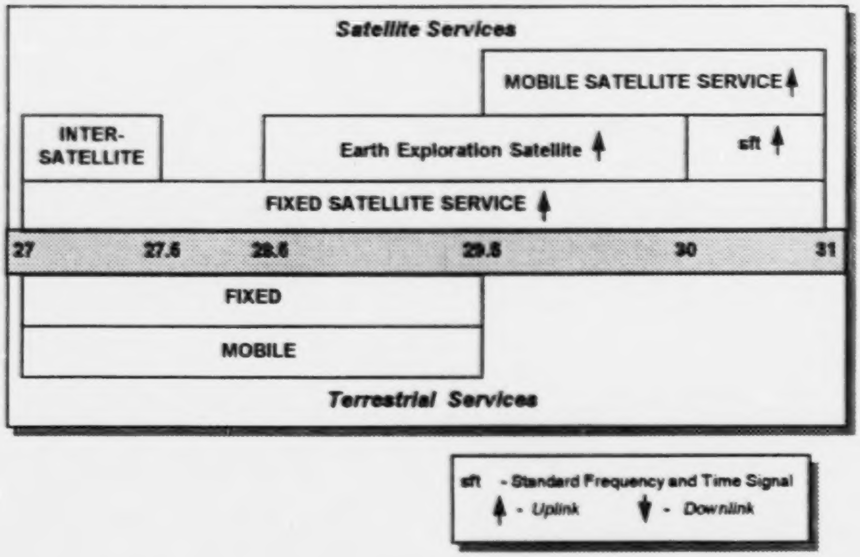

Satellite Services
MOBILE SATELLITE SERVICE
INTER-SATELLITE
Earth Exploration Satellite
sft
FIXED SATELLITE SERVICE
27
27.5
28.5
29.5
30
31
FIXED
MOBILE
Terrestrial Services
sft - Standard Frequency and Time Signal
- Uplink
- Downlink

Figure 2. Ka-Band Uplink Frequency Allocations, ITU-R Region 2.

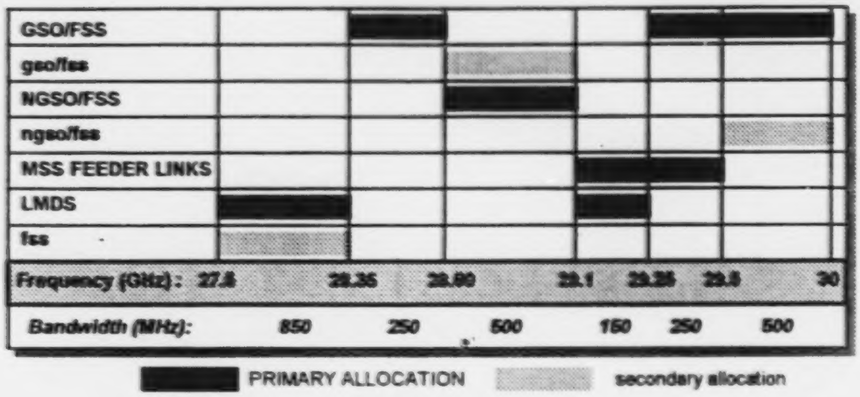

GSO/FSS
geo/fss
NGSO/FSS
ngso/fss
MSS FEEDER LINKS
LMDS
fss
Frequency (GHz): 27.5 28.35 28.60 29.1 29.25 29.5 30
Bandwidth (MHz): 850 250 500 150 250 500
PRIMARY ALLOCATION
secondary allocation

Figure 3. Segmentation Plan Proposed by the FCC for the 28 GHz Band. (NPRM, FCC Docket No. 95-287, July 13, 1995).

Climate Area	Global Model Rain Region	Required Ka-band Rain Margin (dB) *[Difference from Ku-band (dB)]*			
		99.5% Link Availibility		99% Link Availibility	
		30 GHz Uplink	20 GHz Dwnlink	30 GHz Uplink	20 GHz Dwnlink
TEMPERATE MARITIME (Hawaii)	C	5.3 *[4.2]*	2.4 *[1.7]*	3.7 *[3.0]*	1.6 *[1.1]*
TEMPERATE CONTINENTAL (Tokyo)	D	6.9 *[5.4]*	3.3 *[2.3]*	4.0 *[3.2]*	1.8 *[1.2]*
TROPICAL MODERATE (South Pacific)	G	18.2 *[13.8]*	6.1 *[4.1]*	12.6 *[9.7]*	4.1 *[1.0]*

Elevation Angle: 35°
Polarization: Linear Vertical

Figure 4. Rain Attenuation Margin Requirements for the Pacific Region

INTERNET IN CHINA:

GROWTH, COMPETITION AND POLICY

Zixiang Tan
Rutgers University
New Jersey, USA

1. Abstract

After a brief historical review, this paper analyzes the current expansion of and races among various networks sponsored by major government agencies in China. Focuses then turn to the driven forces of network development, competition among institutions, regulatory policy, and network coordination.

2. Introduction

With the global-wide promotion on NII (National Information Infrastructure) and GII (Global Information Infrastructure), deploying Internet has recently turned out to be the top priority in many countries, especially among developing countries.

As a late comer, China is facing a special environment for developing its own Internet. Internet is now a proven application and an obviously lucrative business. On one hand, fostering China's Internet has been added to the top agenda of Chinese government. On the other hand, under the current atmosphere of rushing for profits in China, various organizations and interesting groups are striving to gain a stake to prepare for the Internet's commercial potential. After a brief historical review, this paper analyzes the current expansion of and races among various networks sponsored by major government agencies. Focuses then turn to the driven forces of network development, competition among institutions, regulatory policy, and network coordination.

3. Historical Review

China's computer networks started, as in other countries, from the research and education field of computing technology and applications (Zhang, 1994). However, it has not been able to grow up as pervasively as in many developed countries.

CAnet (China Academic Network) is accredited as the first network in China. It was established in 1987. In 1988, CAnet is able to exchange email with global Internet using X.25 technology via a gateway at Karlruhe University in Germany. In 1990 CAnet registered its top domain "cn" in NIC (Network Information Center) in the US.

CRnet (China Research Network) was established in 1990. This network also uses X.25 link to exchange information with the global networks through RARE in Europe. CRnet hosts more than ten research institutions scattered in several major cities in China.

IHEPnet (The network of the Institute of High Energy Physics of Chinese Academy of Science) has made its network the most widely spread one in China. IHEP established its own Local Area Network (LAN) which supports DECnet in 1988. Its direct international 64 Kbps leased line, which is the first one in China, was established via AT&T's satellite channel to SLAC (Stanford Linear Accelerator Center) in US in March 1993. IHEPnet was further upgraded into full Internet operation in May 1994. In July 1994, the IHEP - SLAC network link has been changed to IHEP - KEK (Japanese National Institute of High Energy Physics in Tsukiba near Tokyo) via ITJ's (International Telecommunication Japan) 64K bps satellite channel. Up till June 1995, IHEP has opened accounts for more than 500 top scientists and professors all over China.

NCFC (National Computing Facilities of China) marks another corner stone in China's Internet history. NCFC is initiated by the three most prestigious technical institutions in China: the Chinese Academy of Sciences (CAS), Tsinghua University and Beijing University. In 1989, NCFC was included in the State Planning Commission's (SPC) Key Research Development Projects. Funding for NCFC was then provided jointly by the State Planning Commission and the World Bank. This project includes a supercomputer center in CAS and three campus networks, i.e. China Academy of Science Network (CASnet), Tsinghua University Network (TUnet) and Peking (Beijing) University Network (PUnet). The construction of the three individual campus networks had been completed by 1992. In 1994, a 64 Kbps satellite link was established with the global Internet and full Internet access became available to the users of CASnet, TUnet and PUnet.

4. A New Wave of Expansion

China's Internet activities were concentrated in the academic field before early 90's. Stipulated by the global Internet fever and lured by Internet's commercial potential, China's central government and various organizations suddenly all recognize the significance of the Internet. New projects and initiatives come out from the academic circle, governmental ministries, and commercial operators.

4.1 Academic Networks

Based on the previous activities in the academic circle, two projects seem to have momentum to gain a nation-wide coverage.

.ChineNet

This is the continuation of China's NCFC network. ChinaNet's managerial structure includes NCFC Steering Committee, an Expert Group and an operating arm, CNC (Computer Network Center of CAS). NCFC Steering Committee is responsible for the decision making for the ChinaNet. Headed by the Vice President of CAS, Madame Hu Qi-Hen, NCFC Steering Committee consists of representatives from CAS, SPC, SSTC (State Science and Technology Commission), NSFC (Natural Science Foundation of China), SEC (State Education Commission), Peking University and Tsinghua University.

ChinaNet's expert group is designed to make proposals and drafts for the operation policy of the ChinaNet. The daily operation is handled by the Computer Network Center (CNC) of CAS. The CNC is running ChinaNet's NOC and NIC functions. Both domestic and international connections of ChinaNet are monitored and maintained by the CNC. CNC is applying for being authorized to run a national NIC named CNNIC.

The ChinaNet has interconnected more than 20 networks in China. The following are included: NCFC backbone, CASnet, PUnet, TUnet, CAnet (China Academic network), CRNet (China Research Network), IHEPnet, SSTCnet (State Science and Technology Commission network), CERNet (Chinese Ecosystem Research Network), USTCnet (University of Science and Technology of China campus network), NFCwan (National Flood Control wide area network), Shanghai regional network, Wuhan regional network, MEFnet (China National Research Center for Marine Environmental Forecasts), National Meteorology Bureau Network, BSTISnet (Beijing Science & Technology Information Society), and IMnet (Institute of Microbiology of CAS network). Macau regional network and Hongkong Chinese University network are also connected to ChinaNet.

The ChinaNet is obviously organized and dominated by CAS which has a strong technology background and a plenty of talents. However, CAS does not have administrative ties with most owners of the networks interconnected with the ChinaNet. That may undermine CAS's ambition to be a national leader among academic networks. Meanwhile, it is not clear how CAS can secure a solid funding to support a national backbone.

.CERNET (China Education and Research Network)

CERNET is initiated by China's State Education Commission in 1993. It is very much an imitation of the US NSF backbone project in the 80's. CERNET is proposed to consist of a nation-wide backbone with international links, eight regional networks and more than 1,000 campus networks. Its goal is to link all the universities and institutes in China in the near future and to connect high schools, middle schools, primary schools and other education and research entities by the end of this century. Recognizing the commercialization trend of the global Internet, CERNET's developers claim that "CERNET has its unique and unreplaceable status among all the Internet competitors in China. We believe CERNET will greatly improve the education and research infrastructure in China and train network experts as well as experienced network end users. In a word, it will help to boost China's education, research and economic developments." (Li & Wu, 1995).

Similar to NSF backbone project, the nation-wide backbone and the global Internet connection are fully funded by the Chinese government through SPC, NSFC, and SEC. The establishment of the eight regional networks and campus networks will utilize funds from local universities and other local organizations.

CERNET's managerial structure includes an Administration Board, Technical Board, National Network Center, Regional Network Centers, and Campus Network Centers. The Administration Board is responsible for making policy. The Technical Board is in charge of the planning, designing, implementation and updating of the network. The National Network Center conducts the backbone construction, maintenance and operation. The duty of Regional Network Centers is to connect the campus networks to the CERNET backbone. The campus network centers maintain their own facilities, set-up usage policies and serve the end users. The locations and serving provinces of regional network centers are illustrated in Table One.

CERNET will not construct its own physical lines, but uses the leased lines from the China Telecom of the MPT and the second carrier, LianTong (China Unicom). The backbone rate starts at 64 Kbps to 2.048 Mbps (E1). There will be one to three international links. The first link is to the United States with the trunk speed of 128 Kbps (256 Kpbs in the near future). Other two are planned to the Asia Pacific Region and the Europe.

CERNET is a solid project with promised funding and close administration relationship under one umbrella, SEC. It is, therefore, well positioned to challenge ChinaNet's leadership among China's academic networks.

4.2. Governmental Administration Networks

Government administrative networks were initiated by the Ministry of Electronic Industry (MEI), together with the user ministries. It was first publicized in the name of "Three Golden Projects" in August 1993 (Outlook Weekly, 1993). By the end of 1995, three golden projects had been expanded to eight golden projects.

Eight golden projects include the following:
.Golden Bridge project which interconnects nation-wide public economic information networks; .Golden Customs project which facilitates all of China's custom offices in a single computer network; .Golden Card project which aims at a nation-wide electronic banking system.
.Golden Taxation project: to computerize China's nationwide tax collection system.
.Golden Enterprises project: to provide demand and supply information for China's industry.
.Golden Agriculture project: to provide electronic services on the comprehensive agricultural information.
.Golden Intellectual project: to connect China's educational and research institutions. It is based on China's Chinese Educational and Research Network (CERNET)
.Golden Macro-Economic Supporting project: to provide strategic information for China's macro economic planning and controlling.

Recently, there are many reports on other government networks including a healthnet to cover major hospitals. The trend is certain that most ministries and provincial governments will join the wave to set up their internal networks.

The JiTong Communication Co. of MEI was assigned by the State Council to be responsible for the coordination of the planning and construction of the "Three Golden Projects" two years ago. However, with the expansion of golden projects, it becomes even more difficult for JiTong to claim the exclusive authority in planning and construction. MPT has already been competing with JiTong to attract and lure large user ministries. It is also believed that the large users will play an important role in the initiation and implementation of those new projects.

4.3. Commercial Networks

.MPT's ChinaNET.

China's physical data networks are now under the construction by the MPT. The MPT has an old network, CNPAC (China National Public Data Network), which uses X.25 packet-switching equipment from Alcatel-SESA in Spain. CNPAC was designed to carry low-rate data between 1.2 and 9.6 Kbps, which could hardly accommodate most traffics from China's Internet.

The MPT began to introduce a new network, CHINAPAC, in 1993. It is designed to be the major public data network backbone in China for the next ten years. Network equipment is mainly supplied by the Nortel and Newbridge. CHINAPAC has covered all the provincial capitals. Efforts have been conducted to expand it into other smaller cities in the next two to three years. The Sprint of US has been contracted to set up the international links and the domestic planning for CHINAPAC. The 64Kbps international link is already in operation.

The MPT has not stopped only to be a carrier for most of China's academic and government networks. More importantly, the MPT poses itself as both a regulator of China's Internet by competing for hosting the CNNIC (China National Information Center) and a dominating commercial service provider. ChinaNET has been formerly announced to provide public commercial services in April 1995. The actual operation is conducted by the provincial telecommunication administrations. BTA (Beijing Telecommunication Administration) has started the full Internet services in Beijing in spring of 1995. About 2,000 new subscribers were added into the BTA's services in the month of July 1995. PTTs in Shanghai and other larger cities has been reported to follow suit (Lu, 1995). It is clear that corporations and rich individuals are the targets of the MPT's ChinaNET.

.Other Commercial Networks.

Internet services are considered as a value-added information services. According to current regulation, the operation is open to the domestic public. After filing a registration with MPT or provincial PTTs, any domestic entity is entitled to operate the services. Of course, operators are required to meet certain standards in terms of the financial status and the technical background.

The immediate potential commercial service providers are operators of academic and governmental networks. First, they have knowledge and facilities. Secondly, they are, directly or indirectly, encouraged to harvest commercial profits. As China tends to promote market economics, grants for academic research have been dramatically cut. Academic institutions and government network centers have been urged to commercialize their achievements to sustain their daily operation. The spread of commercial Internet services provide a timely opportunity.

There are several networks which are involved in providing commercial services although they may not be willing to call themselves commercial service providers. One of CAS's networks has covered most large cities in China. They charge users a few thousand RMB for initial connection and 25 RMB for each hour on line. One government network is charging a similar price for outside users. The next two to three years will definitely see more academic and government networks join the commercial services as long as China does not formulate a law to restrict this kind of operation.

Another level of commercial providers are regional or local network operators. Collecting fees from users is justified to maintain the running of those network centers because they usually do not receive government grants. There are already reports on Shanghai, Wuhan, Shenzhen, and other cities where regional networks provide the public commercial services.

5. Coordination and Competition

The emerging interests and involvement of various organizations will definitely foster the expansion and pervasiveness of China's Internet. This is evidenced from the increasing exposure of mass media on and growing number of publications of Internet issues. It also raises the issues of coordination and competition.

The lack of coordination at both policy level and the technical level has been noticed by several authors as one of the potential obstacles in developing China's Internet (Zhang, 1993; Tian, 1993). China is used to top-to-bottom initiatives. Examples are China's five-year research and development plan which is backed by the State Council, and the High Technology development Program (863 Program) which is approved by Mr. Deng Xiaoping. An initiative without supports from high authority will run into finance and political risks.

China's Internet is largely a project initiated and supported by technical experts and institutions. No top leaders or authoritative State Agencies are seriously involved. The State Science and Technology Commission is expected and willing to take the leadership since Internet is apparently a high technology application. However, the lack of funding prevents them from a deep involvement. The State Planning Commission, who funded the NCFC project, have financial means. But, they do not have interests and manpower to do detailed coordination. Therefore, developing Internet is left to the MPT, MEI, SEC, CAS, and other agencies. Those organizations are in the same level on China's government hierarchy. None of them is willing to be coordinated by others.

In order to coordinate general issues in the information field, China formed a National Joint Conference for

653

State Economic Informatization in 1993. The Conference, consisting of representatives from 24 organizations, is headed by Vice Premier Zou Jiahua. Hu Qili, minister of MEI, is the standing Vice Chairman. The Joint Conference is assigned to formulate the strategy and policy for China's information infrastructure and to coordinate activities among government agencies.

Internet officially falls into the jurisdiction of the Joint Conference. Some activities has been initiated by the Conference. One of them is to organize and host the "Chinese Internet Development Policy and Technology Examination Conference" in August 1995. Being a temporary organization and without a solid financial and administrative base, the Conference can only play a limited role in guiding China's Internet.

Therefore, competition will be the major feature together with growth and development. State Education Commission will threaten the leadership of Chinese Academy of Sciences among academic networks because the former has a solid funding and a close tie with massive campus networks all over the country. Government networks will desperately fight with the MPT to grasp a piece of commercial services. The MPT is unlikely to have a monopoly in commercial services because of several reasons. The lack of law support, diversified demand, limited internal manpower, and the tradition of developing internal systems among large user groups are among them.

In addition, it is very much possible that the largest two academic networks, ChinaNet and CERNET which are most advanced and wide spread in China, may jump into the market to directly compete with the MPT and other commercial providers. It is far from clear who will dominate the commercial internet services in China

6. Interface, Content Regulation and Foreign Involvement

English is the dominating language among global Internet. With a limited popularity, only a small amount of Chinese can directly communicate with each other or with outside world in English. A user-friendly Chinese environment has to be developed to accommodate the growth of China's Internet. A few technical groups in CAS and other universities have been working on it. A large amount of funding is needed to speed up the development.

Content regulation has already been an issue in China. The immediate one will be political oriented content. There has been report of some incidents in IHEPnet regards to disseminating "anti-government" information (CINET-L, 1995). Religious and sexual contents will follow suit to raise debate on content regulation soon. At current stage, service providers are relying on users not to break the line. This is not so difficult with several hundred prestigious researchers and professors and a few dozens of graduate students in the networks. The control will be almost impossible when the number of users increases to tens of thousand.

This situation raises a serious dilemma for policy makers in China. Catching up the commercial benefits and aiding economic development certainly support the spread of China's Internet. However, the Internet makes information flow and exchange with the outside world easy, convenient and timely. This is contradicted to the current political policy which tries to tight the information control. The Minister of the MPT, Mr. Wu Jichuan, has announced that China will certainly imposed some monitoring and restrictions on the contents flowing in her Internet. Mr. Wu claimed that China is capable to implement those restrictions (Lu, 1995). The situation might be very similar to the control on the fax machines and the Direct Broadcasting Satellites (DBS) from other countries. While the total shut-down of China's internet is unlikely to happen, some regulations, either temporarily or permanently, will be applied once the Internet brings in political threatens.

According to MPT's regulation, foreign interests can not be involved in the operation of Internet services. This line has not been broken up till now. MPT has contracted the Sprint of US to provide help in setting up international links and guiding network planning. Some networks such as the State Economic Information Center have been reported to raise funds from foreign institutions or companies. Meanwhile, many foreign companies including Alcatel, Sprint, SUN and CISCO all keep their eyes open on this market.

7. Conclusion

The fever of building China's Internet has already begun. This is a simultaneous movement in government networks and commercial networks as well as academic networks. While the rapid growth is certain, competition will go with the expansion. The lack of coordination both in policy and in technical level has been identified as a major potential obstacle to the development. No solution is obvious in the near future. The next two to three years will be crucial to shape the framework of China's Internet.

References:

Zhang, C. (1994). "China Opens door to outside", Telecommunications Policy. April 1994, pp238-245.

Li, X. & Wu, J. (1995). "Connecting China's Education Community to the Global Internet - The China Education and Research Network Project", INET 95, Hawaii, June 1995.

Lu, J. (1995). "Internet becomes popular in China", ChinaTime Weekly, No. 200, 1995.

Outlook Weekly, (1993). "China's MEI announces the 'Three Golden Projects'", August 3, 1993, pp8.

Zhang C. & Tian, J (1993). CINET-L (China InterNET Technical Forum) Newsletter, No.0 and No.1, 1993.

CINET-L Newsletter (1993), No. 39, 1995.

Zhu, Q. (1995). "Latest development of Internet in mainland China", CALA 1995 Annual Conference June 23-27, 1995. Chicago.

Table One: The locations and serving provinces of regional network centers

National Network Center	Regional Network Centers	Served Provinces
Tsinghua University, Beijing	Beijing (BJ)	Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia
	Shanghai (SH)	Shanghai, Zhejiang, Fujian, Jiangxi
	Nanjing (NJ)	Jiangsu, Anhui, Shangdong
	Xi'an (XA)	Shaanxi, Qinghai, Gansu, Ningxia, Xinjiang
	Guangzhou (GZ)	Guangdong, Guangxi, Hainan
	Wuhan (WH)	Hubei, Hunan, Henan
	Chengdu (CD)	Sichuan, Yunnan, Guizhou, Tibet
	Shenyang (SY)	Liaoning, Jilin, Heilongjiang

Evolving Telecommunications Regulatory Regimes in Developing Countries

Ben A. Petrazzini and Theodore H. Clark
The Hong Kong University of Science and Technology
Clear Water Bay, Kowloon, Hong Kong
bptrazz@usthk.ust.hk / tclark@usthk.ust.hk

1. ABSTRACT

In order to achieve efficient and effective regulation, less developed countries (LDCs) need to address issues related to the role and positioning of the regulatory agency and the nature of the resources available for its operations. On the former issue, it is crucial for LDC governments to provide their regulatory agencies with flexibility, transparency, and autonomy. Yet, regulators in LDCs face both financial and human resources which create barriers for achieving these objectives. This paper addresses these issues and highlight strategies to overcome some problems that LDCs face in the transition to open competitive markets.

2. INTRODUCTION

Until recently, regulation of telecommunication services was not a major concern for most less-developed country (LDC) governments or service suppliers. In general, there was only one company providing services, generally under state-ownership, and the diversity of services provided was extremely limited. As the state also regulated service provision, one might argue that there was self-regulation, albeit limited largely to the rate of return regulation. Even in the US, which has had a long history of regulating private telecommunications service providers, this regulation generally consisted of relatively simple decisions regarding proposed pricing changes and allowable returns for service providers.

The current regulatory scenario in most LDC and emerging nations in the mid-1990s is radically different from the one that existed only a few years earlier. The single national service provider has been replaced or supplemented with multiple companies of various sizes and market power. The preexisting limited range of services has flourished into a myriad of alternatives for customers, including both fixed and mobile access as well as various forms of enhanced services to complement basic network access. This growing complexity of market profiles calls for an urgent and profound reform of the structure, role, mandate, and constitution of the regulatory bodies worldwide.

This paper explores some of the key regulatory issues that have risen in recent years, with special concentration on the problems that less developed countries (LDCs) face in the regulatory arena. In the first section, the paper schematically presents some key issues raised through the current regulatory debate. The second section looks at some of the major dilemmas in current alternatives for regulatory reforms and points to strengths and weaknesses of each choice.

3. DEBATING THE FUTURE OF REGULATION

The debate over the need for and role of regulation in telecommunications services is far from settled. In the mid- and late-1980s, there was considerable controversy over the nature and extent of regulation over value-added services, but few people questioned the role of regulatory agencies in setting "rules of the game" for basic services. In the mid-1990s, the terms of the debate have changed considerably, with some voices even calling for the abolishment of all telecommunications regulation.(1) New Zealand is cited as the new model by these advocates for a totally unregulated telecommunications market.

Despite this increasingly popular call for eradication of all telecommunications regulation, some industry observers and participants view this approach as a naive perception of the virtues of market forces. They argue that in the telecommunications industry, market reform calls for a new regulatory paradigm rather than the abolishment of all regulation. Even leading advocates of market-oriented reforms have argued that "the search for better regulatory solutions merits high priority in the design of sector reforms."(2)

One of the underlying problems hindering the resolution of this debate is that there is no definite evidence to support either of the two positions, nor is there a "best practice" in the industry as to the degree or kind of regulation governments should aim to provide. The cases of Japan and New Zealand are clear evidence of these dilemmas. Japan portrays a regulatory environment that can be pictured as detailed and heavy handed regulation. New Zealand offers the opposite scenario, a regulation that is so "light handed" that it is almost inexistent. Although the Japanese government appears to have no second thoughts with regard to its approach to regulation while the current New Zealand administration is reviewing its regulatory strategy, neither approach can be seen to manifest clear flaws that call for an immediate reverse course on the path followed by either nation thus far.

Despite the lack of unchallenged proof in support of or against the presence of regulation, there is some evidence that abolishing regulation can have considerable costs. These costs include underinvestment, potential losses of economies of scale if interconnection becomes a burden, reduced performance of unregulated monopolies, and losses of technical efficiency.(3) Aside from the evidence in favor of or against regulation, there are clear indications that most governments around the world will continue to exercise some form of regulatory control over the telecommunications industry for years to come. In view of such, the rest of the paper explores common challenges and opportunities that regulators face in their efforts to guide developments in the industry.

4. INSTITUTIONAL ARRANGEMENTS AND RESOURCES

The success or failure of the agency in achieving improvements in the operations of the local telecom market is strongly linked to the institutional arrangements that underlie the agency's operation, and the resources that it can mobilize in support of its operations. There are several issues, such as the size and internal structure of the regulatory agency, that relate directly to the regulatory goals of the country, the feasible resources, and other country-specific variables. Some of these issues will be left for consideration in country specific studies. This paper will only address issues that are more general and of concern to most nations.

4.1 Regulatory Flexibility and Transparency

Frequent technological innovation and rapid changes in market profile have raised the need for a regulatory framework that is flexible enough to grant the regulator the leeway, necessary to adjust the rules of the game to the ever changing telecommunications market conditions. This is the dominant trend in countries with solid experience in regulating the sector under competitive conditions. Although this approach seems ideal as a means to fine tune conditions for effective competition and improved technological efficiency, it might not be viable in LDCs for two reasons. First, due to the often unstable economic and political environment existing in most LDCs, investors tend to require clear and detailed licensing or contract conditions which are also embodied in long-term legal instruments that cannot be easily turned around if political conditions change.(4) Second, regulation that is too general and undefined requires a very proactive role on the side of the regulator, which most LDCs cannot afford due to resource limitations. The high cost of intense regulation in convergence with the poor human and financial resources of most regulatory agencies in LDCs restricts the ability of regulators to play an active role in permanent fine tuning regulation. A fixed and detailed legal instrument might operate to the detriment of an up-to-date regulation but it grants investors safe ground and regulators a partial solution to the problem of limited resources.

In LDCs, investors' confidence is not only based on clear and detailed regulation but also on the transparency of such regulatory process. Transparency of government decision making has always been a principle more often preached than practiced---especially in LDCs. In the telecommunications sector during the era of regulated monopolies, maintaining or establishing a transparent regulatory process was not a major public or commercial concern. Today, with rising competition in every segment of the market and the globalization of capital, the issue of transparency in the policy and regulatory process has become crucial. A transparent regulatory process is less an issue of democratic principles than a pragmatic business strategy which strengthens local telecom markets.

During the hype of telecom privatization in LDCs in the late 1980s, global capital seemed to be abundant and was easily lured by the business opportunities offered by the telecommunications sector in developing countries. In the mid-1990s available capital has become increasingly scarce.(5) However, with expanding information demands from business and residential users, the need for capital has not diminished. As the competition for capital grows and the attractiveness of emerging economies cools down, investors have become more careful in their evaluation of potential investment opportunities.(6) It is in this context that transparency of the regulatory process becomes crucial to gain the long term commitment of investors. Lack of transparency not only discourages new investment but also discourages greater capital commitment from those who are already operating in the market. The costs generated by the lack of transparency and reliability in the legal and political system is manifested in some Latin American countries where investors demand high rates of return to recover investments quickly.

Lack of regulatory transparency also has negative effects on the promotion of competition. The success or failure of new competitors in telecom markets today is closely tied to conditions and terms of interconnection, and since fair terms and conditions generally require the intervention of the regulatory agency, a transparent process or the lack of it will probably have important consequences in stimulating or deterring new entry. In these cases, the possibility of a judicial review could provide the required confidence in the system and strengthen the commitment of newcomers.

4.2 Regulatory Autonomy

Much of the regulatory flexibility of the agency will heavily depend on the autonomy that it gains from the various interest groups and constituents that have considerable leverage to influence and distort the decision-making process. An important goal embedded in the process of telecommunications privatization in LDCs has been the "de-politicization" of service provision. Nations no longer afford to run their telecom services on the basis of political preferences and priorities due to the economic and commercial importance of these services. Significant benefit has been achieved in many countries through transferring the control of these monopoly carriers to the private sector.

A similar "de-politicization" logic underlies the drive to restructure the regulatory process by creating relatively autonomous agencies operating at "arm's length" from the legislative and executive government. However, much less progress has been achieved by LDCs in this area of reform. One problems is that the appointment, surveillance, reporting structure, and budgetary allocations of regulators are still closely tied to the various branches of the central government administration. In several countries, the head of the executive branch (e.g., president or prime minister) still plays an important role in the life of regulatory bodies, indirectly through the appointment of regulators and/or directly via intervention in politically sensitive regulatory decisions.

Presidential or prime minister mandate grants the regulator legitimacy from the highest stratum in the government. One positive aspect is that such a powerful relationship tends to shield the regulator from the often intense and many times contradictory pressures of the national legislative bodies. But, marginalization of the legislative role diminishes the legitimacy of the body's decision making. In other words, decisions of the agency and the selection of its appointees under one administration can be seen as unilateral and, therefore, challenged by the following administration if the government changes hands.

A closed regulatory process is also a fruitful ground for the influence and lobbying of powerful interest groups.(7) In general regulatory agencies and political bodies are more vulnerable to pressures from industry than from consumers (or even from members of the legislature that are representing consumers) for three main reasons. First, regulatory decisions generally have a higher and more clear monetary value for industry than for consumers on an individual basis. Second, service providers generally enjoy a higher degree of financial and human resources to lobby government than consumer groups. Finally, the industry is often able to organize and coordinate actions and express their views and concerns as a group easier than consumer groups, who find it difficult to coordinate the interests of a large number of generally unorganized individuals. Thus, individual consumers tend to have low economic and political power in most LDCs compared with service providers and industry groups.(8) Nevertheless, suspected favoritism in policy decisions can lead to social discontent and political instability, ultimately harming all parties involved, including consumers.

Although powerful interest groups are generally more influential, there are particular historical circumstances in which regulators bend to public pressures and play in favor of consumers. That is clearly the case of a recent review of price caps for electricity in the UK, where the regulator, Littlechild, decided to revise the cap of prices for electric services because they were too high. Littlechild had not decided to review the price cap to adjust for reduced costs due to technological innovations and improved industry efficiencies, as regulators are expected to do after a certain period of time (every five years for UK utilities). Instead, Littlechild had already agreed with the companies involved on an acceptable price cap, but later, had second thoughts and decided to lower prices because they were still too high, presumably due to pressures from consumer groups.(9) The consequence is that confidence of companies and investors in the regulatory agency has been hindered.(10)

This struggle among various interest groups to "capture" or influence regulatory policy making for their own benefit illustrates the kind of pressures that most regulatory agencies have traditionally faced in their daily operations. Confronted with powerful attempts to influence decisions from various groups, and hampered by their weak positions in the political arena, regulators often tend to delay resolution of sensitive issues to avoid conflict.(11) For this reason, it is extremely important for any regulatory agency to have strong statutory power and a high level of autonomy in its decision making. Yet, the irony of greater autonomy is that an agency with increased statutory power and autonomy becomes an even more attractive target for "capture" than a weak, passive, or non-autonomous regulator. The active role and concentration of power in the regulator sends a clear signal to industry regarding whom they should target for lobbying if decisions are to be influenced. (12)

Although increased autonomy and higher statutory power might augment the visibility of the regulator and its allure as a target for capture, that same visibility can serve to shield regulation from "capture" by market participants. In the past, most regulatory activities were carried out behind closed doors, and most decisions were taken with only the participation of the regulator and the regulated. In current open competitive markets, autonomous regulatory agencies tend to carry their decision making in an open public fashion through hearings, public notices, and published documents. In such circumstances, they are highly exposed to public and private scrutiny. Therefore, the more autonomous the agency and the more publicly visible the decision making, the less likely the chances of regulators being captured by any interested party. This does not mean that regulatory decisions are not prone to the influence of special-interest groups, but it does suggest that regulatory capture is less likely under these open conditions than in the past.

4.3 Financing Regulation

It is important to keep in mind that granting the regulatory agency considerable autonomy through written legislation might not mean much in practical terms. The formal autonomy conceded by law can be easily undermined if the institution does not have financial autonomy. The sources and management of the agency's budget are key elements in the autonomy of the regulator. Regulators operating under traditional regulatory schemes tend to be constrained by the fact that the central government is the one which controls the scope and allocations of budgetary resources. It is generally the minister of economy or secretary of finance that determines the amounts allocated to the various items in the budget and the regulators cannot manage nor reallocate resources according to the changing needs of the agency and demands of the sector.

To overcome some of the problems generated by these budgetary straight jackets, some regulators have won government approval to create an independent telecommunications trading fund.(13) The trading fund allows regulatory agencies to operate on a quasi-commercial basis, while remaining part of the government. This new financial and accounting framework allows operators to independently collect and manage revenues from licensing fees or other financing sources without the constraints and bureaucratization traditionally imposed by centralized budget control. Under these schemes, agencies would have enough flexibility for an efficient use of resources to respond to the new demands of an ever-changing telecom market.

In most developing countries, however, the problem of financial resources goes beyond the issue of who controls the budget into the very basic question of how to raise enough funds to run the agency. Therefore, in LDCs, lack of financial resources not only undermines the autonomy of the agency, but also hinders the ability to perform its most basic functions. Without adequate resources the regulator can turn into "police without stick", weakening the ability to enforce the rules and policies established. One critical problem is that the regulator's budget is generally part of the larger national budget, and telecommunications requirements generally give way to more politically sensitive matters, such as social welfare programs.

Therefore, an independent source of financing becomes crucial for the operations of the regulatory agency. Some governments have begun to rely on licensing fees to finance regulatory operations.(14) Others have ruled that financing should come from the revenues of the carriers operating in the local market.(15) These approaches to raising funds are attractive for LDCs because they remove the financial burden from the state and provide regulators with a reliable, stable, and relatively independent source of income.

Theoretically, these strategies should solve the financial problem of regulatory agencies in LDCs. In practice, however, the approach is not without problems. Although the funds are legally allocated to the regulatory agency, more powerful agencies within the government--such as the Ministry of Economy--often gain control over the resources and return to the regulator only a small amount for its operations.(16) Dependency on revenues from service providers can also lead to a collusion of interests between the regulator and the regulated firms, to the detriment of the consumer. This trend is more likely in closed and politicized markets--like those of LDCs--than in open competitive environments.

Regulators are supposed to play the role of impartial arbitrators among industry players and between them and consumers. Yet, since their decisions have high value for industry, consumers, and governments, the regulators can easily become capture targets for various interest groups which would try to bend regulatory decisions to their benefits. Financial dependency on either service providers or politicians make regulators vulnerable to pressures from industry, government officials, politicians, and consumer groups (which may hold considerable political power if they can be effectively organized).

For these and other related reasons, the creation of an international funding agency--under ITU or UN sponsorship--to provide financial resources to regulatory agencies could grant a partial buffer to the pressures that agencies face in their operations. This seems particularly appropriate since effective regulation of telecommunications services today is as much a global concern as a national one. This international subsidy need not completely replace national funding for regulation, but could still provide an important stabilizing role as long as a substantial portion of the agency budget is available from an independent entity outside the control of local and national economic and political interest groups.

4.4 The Human Resources Deficit

The lack of adequate skill resources for regulation of telecommunications in LDCs is one of the casualties of inadequate and unstable funding of regulatory agencies. The need for stability and independence of funding is critical for human resource development, since salaries represent up to 90 percent of the annual expenditures for most regulatory agencies. With regulatory issues becoming more complex, the need for skilled and trained human resources in regulatory agencies is more important today than ever before.

The human resources required to identify and assess the implications of these complex issues and to formulate clear policy aims and evaluate policy options stretches regulators in MDCs to their limits. The difficulties facing regulators in LDCs with few resources, human or otherwise, are by no means balanced by the current state of development of the networks in their countries. For example, multimedia may not yet be an issue facing LDC authorities, but the advent of satellite TV is important, as are issues such as interconnection terms and pricing between networks, tariffing policies, liberalization of data communications services, and the continuing need to provide universal service on demand at affordable rates. Some industry advisors even argue that the issues, opportunities, and challenges that regulators in LDCs have to deal with may even be more complex, since the lack of existing infrastructure provides greater opportunities and flexibility for introducing new services and forms of competition than would be considered viable in a nation with a more established telecommunications and entertainment infrastructure.

Although most LDCs suffer from a serious human resources deficit, it is important to point out that it is not always necessarily linked to quantity of personnel as much as to the skewed distribution of skill, training, and expertise of the staff. Governments in the developing world often have used the state enterprises and agencies to buffer unemployment problems. Hence, regulatory agencies, like many state controlled bodies, may have an abundance of labor, but this personnel may not have adequate training or skill to handle the growing complexity and diversification of the telecom market. Moreover, agencies are still dominated by personnel with a professional profile more tuned to the era of basic service monopoly (engineers), than to a competitive and diversified service market (which requires accountants, finance and policy analysts, economists, lawyers, etc.)

To address this concern, some funding provided by independent international agencies could be earmarked for training and development of regulatory personnel, rather than simply providing a subsidy for existing operations. In addition, skilled telecommunications regulatory advisors could be loaned to LDC regulatory agencies, with the understanding that these experts would be expected to provide both a consulting and an educational role. The cost of these expert advisors could be heavily subsidized by these international agencies to encourage LDCs to take advantage of skills and resources that otherwise would be considered economically unviable within the existing political and economic constraints, under which most regulatory agencies operate currently. Even limited international subsidies could have a substantial impact on regulatory decision making over time through encouraging the use of high skilled resources within LDC regulators and the training of existing ones. Additional subsidies of operating costs would further protect this investment in development of skilled and expansion of talented resources within these developing and evolving regulatory agencies.

5. CONCLUSION

There is an on going, unsettled debate over the fate, scope, and nature of regulation in current telecommunications markets. Some have strongly argued for the abolishment of all kinds of regulation. In their view, developments in the industry should be left to market forces and, as a last resort, to judicial intervention based on general competition laws.

Arguments against such strategy point to the fact that general competition laws are designed to regulate an already competitive business market in order to preserve diversity and avoid concentration of market power. Telecom markets represent quite a different situation in which the goal is to break an existing monopoly and to introduce, protect and nurture diversity in competition that never existed before. Furthermore, it has been argued that the absence of regulation will most likely lead to high costs for both the industry and consumers. These costs can take the form of under investment, potential losses of economies of scales if interconnection becomes a burden, reduced performance of unregulated monopolies, and losses of technical efficiency.

The practical experience to date in MDCs has also pointed to the need for some kind of regulatory intervention. Apart from the difficulties new entrants have in wrestling a substantial market share from the dominant carriers, the trajectory of technology in this industry is to erode continuously the boundaries between the regulated telecoms sector, the semi-regulated media sectors, and the unregulated computer sector. Multi-media developments are the most obvious examples of this. These developments are creating a new range of regulatory issues, such as cross-ownership, cross-subsidy, access, security, and so on, shifting the goal posts in this game of regulation-deregulation-reregulation.

However, regulation itself is not enough. What is needed is sound, efficient, and effective regulation. To achieve this, countries have to address issues related to the institutional arrangements of the regulatory agency and the resources available for its operations. For most LDCs, the most troubling aspect of this initial transition from monopoly to competitive markets is the need to re-engineer the regulatory agency. Yet, for such restructuring most nations face two basic constraints: financing and human resources.

On the financing issue, regulators should look for various forms of self-financing--such as licensing fees or some form of taxation on the carriers' revenues. In addition, international groups interested in promoting more efficient and effective regulation of global telecommunications could provide some financial subsidies to encourage agency independence and stability.

For the human resources issue, the objective is not to have a large regulatory body, but a slim, efficient, and highly professional institution. Due to the difficulties that LDCs face in this regard, the international community--and particularly the G-7--should take the lead in supporting staff development in developing countries, including providing both skilled human resources and financial assistance where needed.

Aside from financing and human resources, it is crucial for governments to be sensitive to the needs for regulatory flexibility, transparency, and autonomy. Although some of these goals are, at this stage, beyond the reach of many LDCs, governments should strive to achieve them in the short run, not so much because they are compatible with good democratic practices, but because they are crucial to attracting private investment and consolidating a stable growth of the national telecommunications infrastructure.

In sum, the presence of a well endowed regulator in emerging telecom markets seems to be crucial in this period of transition from monopoly to competitive markets. However, the challenges that lay ahead for most developing countries are significant enough to call into question the prospects of strong, independent regulatory bodies capable of crafting sound regulatory decisions for the sector.

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1 See, for example, Egan 1994, and Huber 1995.

2 Wellenius, et. al. 1993

3 See Smith and Staple 1994.

4 Nikhil Sinha 1995.

5 Harrington 1994.

6 The economic and financial debacle in Mexico, and some sour experiences of major telecom investments--such as that of the Venezuelan privatization--have affected the confidence of international investors in LDCs markets, and in the telecom sector in particular.

7 Horwitz 1989, 28. This is even more viable in LDCs, where governments are making big efforts to please business with their market outlook. The support of business at this stage of economic development has become crucial to move economies out of stagnation.

8 Noll 1983.

9 Littlechild's decision, which clearly benefit consumers, is presumably linked to a growing public discontent in the UK with the performance of privatized public utilities. Consumers blame the regulators for their inability to curve prices and reduce profits in the privatized companies. Recent events in the electric sector seems to play into the hands of consumers demands. See The Economist, 11 March 1995, 61 and 90.

10 Clear evidence of such reaction is the fact that shares prices dropped immediately after the announcement of the price cap review. See The Economist, 11 March 1995, 90.

11 Horwitz 1989, 85.

12 Furthermore, one could argue that a proactive regulator speaks of its receptiveness to introduce innovations or review recently introduced reforms, increasing even further its value for those that intend to affect the regulatory process.

13 Like the Office of the Telecommunications Authority (OFTA) in Hong Kong.

14 Examples of this strategy are Hong Kong and Philippines.

15 This is the case of Argentina, where the new regulatory agency, the Comision Nacional de Telecomunicaciones (CNT), is supported by 0.5% of the revenues of the companies that provide telecommunications services in the country.

16 In Argentina the Ministry of Economy has taken control of the revenues, and discretionally allocates to the regulator a sum that is always smaller than the one the agency received from the carriers.

REFERENCES

Arena, Alex. "Regulation and Resources." Paper presented at The Economist Conference: *Telecommunications Challenges in Asia: A Roundtable Dialogue*. Hong Kong, 28 June 1994.

Beesley, M. E. and S. C. Littlechild. "The Regulation of Privatized Monopolies in the United Kingdom." *The Rand Journal of Economics* 20, no. 3 (1989): 454-472.

Blanchard, Carl. "Telecommunications Regulation in New Zealand: How Effective is 'Light-Handed' Regulation?" *Telecommunications Policy* 18, no. 2 (March 1994): 154-164.

Dholakia, Ruby R. and Nikhilesh Dholakia. "Deregulating Markets and Fast-Changing Technology." *Telecommunications Policy* 18, no. 1 (January 1994): 21-31.

Egan, Bruce. "Building Value Through Telecommunications: Regulatory Roadblacks on the Information Superhighway." *Telecommunications Policy* 18, no. 8 (1994): 573-587.

Glynn, Simon. "Japan's Success in Telecommunications Regulation: A Unique Regulatory Mix." *Telecommunications Policy* (January 1992): 5-12.

Helm, D. and G., Yarrow. "The Regulation of Utilities." *Oxford Review of Economic Policy* 4, no. 2 (1988).

High Jack, ed. *Regulation: Economic Theory and History*. Ann Arbor: The University of Michigan Press, 1991.

Horwitz, Robert B. *The Irony of Regulatory Reform: The Deregulation of American Telecommunications*. New York: Oxford University Press, 1989.

________. "Regulation of Parastatals." Paper presented at the Economic Trends Research Group Conference. Cape Town, South Africa, June 1992.

Huber, Peter. "Abolish the FCC." *Forbes* (13 February 1995): 184.

"Incredible ." *The Economist* (11 March 1995): 90.

Mansell, Robin. "Strategic Issues in Telecommunications: Unbundling the Information

Infrastructure." *Telecommunications Policy* 18, no. 8 (1994): 588-600.

McCarty, David W. "Playing the Regulatory Game: Network Modernization." *Telecommunications Policy* (September 1992): 531-537.

Noll, Roger G. and Bruce M. Owen. *The Political Economy of Deregulation: Interest Groups in the Regulatory Process.* Washington, D.C.: American Enterprise Institute, 1983.

Noll, Roger G. "Telecommunications Regulation in the 1990s." In *New Directions in Telecommunication Policy*, ed. Paula R. Newberg. Durham: Duke University Press, 1989.

Schultz, Richard J. "Regulation and Telecommunications Reform: Exploring the Alternatives." In *Implementing Reforms in the Telecommunications Sector: Lessons from Experience*, Bjorn Wellenius and Peter A. Stern. Washington, D.C.: The World Bank, 1994.

Sinha, Nikhil. "Regulating Telecommunications in Developing Countries: An Institutional Analysis." Paper presented at Pacific Telecommunications Conference: Convergence: Closing the Gap. Honolulu, Hawaii, 22-26 January 1995.

Smith, Peter L. and Gregory Staple. "Telecommunications Sector Reform in Asia: Toward a New Pragmatism." *World Bank Discussion Papers* 232 (1994).

"The Regulatory Experiment." *The Economist* (28 January 1995): 72.

Veljanovski, Cento. *Regulators and the Market.* London: The Institute of Economic Affairs, 1991.

Wellenius, Bjorn and others. "Telecommunications: World Bank Experience and Strategy." *World Bank Discussion Papers* 192 (1993).

Developing Competition in Local Fixed Networks in Hong Kong

M H Au, Assistant Director
Office of the Telecommunications Authority (OFTA)
Hong Kong

ABSTRACT - As from July 1995, competition has been introduced in the operation of local fixed network services in Hong Kong. Instead of a duopoly approach, four operators, including the incumbent operator, have been licensed to operate the services on a competitive basis. The primary role of the Hong Kong Government in developing competition in the services is to establish a fair regulatory environment for all operators. Important regulatory measures to promote competition include exercising control over the numbering plan, mandating number portability, determining terms and conditions for interconnection, facilitating access to customers, regulating the prices of the dominant operator and keeping watch on anti-competitive behaviours in the market.

INTRODUCTION

Until the end of June 1995, there was only one local public switched telephone network in Hong Kong, operated by Hong Kong Telephone Company Limited (HKTC) as an exclusive franchise under the Telephone Ordinance (all laws enacted by the legislature in Hong Kong are called "ordinances"). This exclusive franchise was extended a number of times in the past, the last time being in 1975 for 20 years up to 30 June 1995. The exclusive franchise covered only the fixed wireline network - mobile telephone networks have always been in the competitive arena. The operation of networks for the carriage of non-telephonic signals (such as facsimile and data) was also not within the exclusive franchise of HKTC. There was, however, no commercial incentive for the construction of fixed networks just for the carriage of non-telephonic services. Thus the network of HKTC became the only public fixed telecommunication network in Hong Kong.

The first attempt to introduce competition in the local fixed network market was made in the late eighties when an operator was chosen to build a cable television network which could provide the infrastructure for a second telecommunication network. However, for various reasons, the chosen operator decided not to proceed with the investment. One of the reasons was probably that the prohibition on the provision of voice telephony services over the second network before the expiry of HKTC's franchise in 1995 did not make the investment in the second network commercially attractive.

In 1992, the Hong Kong Government completed a comprehensive review of telecommunication policies and decided that the exclusive franchise of HKTC should not be renewed upon its expiry. HKTC would continue to be licensed to operate its network, but under a non-exclusive licence in competition with new operators. The Government invited applications for local fixed network licences in October 1992 and announced that four operators, one of which was HKTC, were to be licensed to operate local Fixed Telecommunication Network Services (FTNS) as from 1 July 1995. The three new operators are New World Telephone Limited, New T & T Hong Kong Limited and Hutchison Communications Limited. The licences were granted in June 1995 after coordination with the Chinese Government through the Sino-British Joint Liaison Group because the licences straddle 1997 when the sovereignty of Hong Kong will revert to China.

WHY COMPETITION?

Local fixed network services in Hong Kong have reached a highly developed status. As at the end of October 1995, the penetration of telephone lines was 52 lines per 100 people. This is comparable to the penetration in the most-developed countries. Penetration of facsimile lines (approximately one facsimile lines every five business lines) is also among the highest in the world. Telephone lines are readily available on demand. There is practically no queuing time for service provision. For a relatively cheap fixed monthly rental, the customer is allowed to make an unlimited number of calls within Hong Kong.

The mobile telecommunications market in Hong Kong is vibrant and highly competitive. There are four licensees operating cellular radiotelephone services using the analogue and digital technologies. After the analogue to digital transition currently in progress, there will be five digital systems conforming to a variety of European and North American technical standards. As of the end of October 1995, the penetration for cellular services was over 10%. The penetration of 20% for paging services operated by nearly 40 licensees is one of the highest in the world.

It is against the background of a highly developed telecommunication infrastructure that Hong Kong is poised to introduce liberalization in the local fixed network sector. In other countries, liberalization is usually introduced in customer premises equipment, mobile and value added services. Then liberalization will spread to international and long-distance telephone services. The last sector to be liberalized is usually the local wireline telephone services. Hong Kong has liberalized the market for customer premises equipment in 1982. Mobile and value-added services have always been in the competitive arena. Hong Kong, being a relatively small territory, has no "long distance" sector. In the international sector, the constraint is an exclusive franchise awarded in 1981 for a period of 25 years to Hong Kong Telecom International Limited (HKTI). Until 30 September 2006, there can only be one operator for international telephone services in Hong Kong. The Government said that it would honour the exclusive franchise which has been granted, but would liberalize in areas outside the exclusivity of HKTI. Thus for the time being, the only sector remaining for further liberalization is the local fixed network services.

Although HKTC has provided Hong Kong with a high-quality and inexpensive local telephone service, consumers are no longer satisfied with the choice of services from only one single supplier. Competition is expected to bring benefits to consumers in terms of quality of services, responsiveness to customer demand, innovation and prices of services. Although the penetration of telephone lines is already at a mature level, the annual growth rate for telephone lines has maintained at a level of around 6% per annum in the past five years. This growth rate is expected to continue as the economy in Hong Kong expands. The Hong Kong local fixed network sector provides customers with access to the only international telephone service of HKTI and therefore is entitled to a share of the revenue from the international services. Thus the local fixed network market is bigger than the mere provision of local telephone services. Competition in the local fixed network services could bring about reduction in the cost to consumers in accessing the international telephone services.

It is not only telephonic services that provide growth in the future. The most significant growth area will be non-telephonic services (i.e. data, images and text). The local fixed networks will form the future "information superhighways" within Hong Kong. The networks will provide the infrastructure for the transport of all sorts of information between fixed points in Hong Kong, including emerging services such as video-on-demand and interactive multi-media services. The revenue potential in these growth areas provides attractive opportunities for potential investors.

According to an economic study carried out as part of the telecommunication policy review in 1992, although competition would inevitably lead to some duplication in infrastructure investment, the cost will be more than offset by the benefits to the community in terms of the improvement in efficiency in the operation of the services and the price reduction to consumers. In other words, competition will bring about a net economic gain to the community.

WHY FOUR OPERATORS?

The Hong Kong Government has always adopted the policy of a "free market". That is to say the Government would not intervene in the market unless it is absolutely necessary to do so. The Government believes that market forces, rather than the regulator, would be in a better position to determine the number of operators. Such a policy has led to a thriving market in mobile and value-added services. The Government has adopted the same "market driven" open licensing approach in the licensing of local fixed networks, rather than tendering for a second network to form a duopoly. Potential operators were asked to conduct their own market research to estimate the number of operators the market could support. After receipt of the proposals, the Government went through the business plans of the proposers and employed a financial consultancy firm to carry out an economic study of the local fixed network market. The economic study included the commercial viability of the operation with different number of operators and the net economic benefits to the community as a result of competition. The market research of the potential operators and the study of the Government consultant confirmed that the size of the local fixed market will continue to grow. Despite the introduction of the new players and the inevitable erosion of market share of the incumbent operator, HKTC, the remaining market share for HKTC will continue to grow. The market share of the new operators was big enough to support three new players.

PROVIDING A FAIR ENVIRONMENT FOR COMPETITION

Although it is not the function of the Government to underwrite success of the new operators, the Government has an interest to see to it that competition can flow to as wide a cross section of consumers as possible in the shortest possible time. HKTC undoubtedly is a dominant operator in the market, and is commanding formidable market power. It has an extensive network infrastructure. It has knowledge about the market and established relationship with the customers. To ensure success of competition, the Government has to provide a fair regulatory environment so that the new operators can be given a fair opportunity to gain a foothold in the market.

Regulatory Authority

The Government realized under the new competitive environment, there are bound to be disputes among operators which need a regulator with sufficient powers to deal with the impasse situations impartially and effectively.

In 1993, the Government introduced amendments to the Telecommunication Ordinance to provide for a series of powers for the Telecommunications Authority (TA) to effectively regulate the telecommunication market in a competitive environment. These include the powers to control the numbering plan, to determine interconnection, to direct compliance with licence conditions and to impose financial penalty.

In 1993, the Telecommunications Branch within the Post Office, which used to be responsible for the regulation of the telecommunication sector, was separated from the Post Office to form a new department called the Office of the Telecommunications Authority (OFTA). The Director General of OFTA is appointed as the Telecommunications Authority (TA) who is the public officer vested with the responsibility and statutory powers under the Telecommunication Ordinance to regulate the telecommunication industry. A number of staff with the necessary expertise was added to the establishment of OFTA. This provides the TA with the required support to cope with the new regulatory environment.

Hong Kong has not adopted the model in some countries where a regulator in the form of an "independent" agency is established. OFTA is still a Government department. The TA is however given the appropriate autonomy to "get on with the task", based on law and adhering to the policy framework laid down by the Government, to take and enforce decisions with minimal interference. TA's decisions are of course subject to the usual checks and balances. Apart from being accountable within the executive arm of the Government, the TA's actions are subject to scrutiny by the legislature and possible review by the judiciary.

Control of the Numbering Plan

As HKTC was the only operator of the public switched telephone network in Hong Kong for many years, the telephone numbering plan was traditionally developed and controlled by HKTC. The fair access to numbers in the numbering plan is a crucial element in the development of fair and effective competition. Any discrimination in the allocation of numbers to operators would prejudice healthy competition. Through legislative amendment, the powers to manage the numbering plan was vested in the TA as from 1993. The TA conducted a review of the usage of the numbers in Hong Kong with the assistance of a consultant, decided that it was necessary to migrate to an 8-digit number plan so as to provide sufficient space for the development of competition. It was also decided that to provide a fair competition environment, all operators should use numbers of the same structure (i.e. same lengths for numbers for customers as well as access to services).

Number Portability

It was established that without operator number portability, it would be rather difficult for the new operators to attract customers as customers would be reluctant to change operators if their telephone numbers have to be changed. Changing telephone numbers require replacement of stationery and long-established customer contacts may be lost. Thus the TA issued directions to the operators mandating that operator number portability should be provided from the commencement of services operated on a competitive basis. As the installation of an intelligent network platform to implement number portability would not be completed until the end of 1996, the TA decided that initially number portability is to be effected by simple call-forwarding.

Interconnection

The new networks could not function in isolation with other networks. Without interconnection, they would not be able to attract customers. The Telecommunication Ordinance has provided for the powers of the TA to direct interconnection and determine the terms and conditions of such interconnection. As the determination of interconnection amounts to an interference to the freedom of contract, such determination will be made only if public interests justify the determination. The operators concerned will be given a reasonable opportunity to arrive at an interconnection agreement on a commercial basis, and if they fail to conclude a commercial agreement within a reasonable period, any party may request the TA to make a determination. The TA may however make a determination without waiting for requests from operators for a determination. The main consideration of the TA is whether public interest justifies the interconnection. The terms and conditions which may be determined by the TA include technical and commercial terms and conditions. Thus the TA may determine the points at which the interconnection should take place as well as the interface specifications. The TA may also determine the interconnection charges payable by one operator to another operator. The underlying principle is that no operator should obtain services without paying a fair compensation to the operator providing the services.

As in other countries where competition has been introduced, the determination of interconnection agreement is likely to be a difficult process and involves controversial issues. Although no formal determination has been made so far on the interconnection between local fixed networks, the TA has issued a series of statements in the months of May and June 1995 providing guidelines concerning interconnection. The issue of such statements has proved to be a helpful step short of the making of formal determination which has to follow a rather time consuming and legalistic due process.

The level of interconnection charges is significant to the operating costs of the new operators. To promote competition, fair bases for the determination of the interconnection charges have to be established. The TA has already announced that interconnection charges should be based on the reasonable relevant costs which includes the cost of capital. The relevant costs will be measured on the long-run average incremental costs, including a cost of the assets used. The current cost of assets is the most economic replacement cost of the remaining service potential of the existing assets. Until such time that current cost accounting capabilities are developed to a satisfactory level, costs should be determined with reference to historical values recorded in books of account.

Access to Public Streets

The operators cannot roll out their networks unless they have access to public streets for the laying of ducts and cables. All fixed network operators are therefore accorded the so-called "utility" status which gives them the right to open up roads for network installation and maintenance. However, uncoordinated laying of cables and ducts would lead to unacceptable disruption to the environment. Therefore the operators are required to coordinate their road opening requirements for cable ducts. A coordination committee is convened by OFTA and a procedure is developed whereby each operator notifies the other operators of their planned opening requirements. If the other operators have similar requirements, the operator carrying out the road opening will have to incorporate the requirements of the other operators in the project. The other operators will of course have to share the costs of the road opening. Through this arrangement, the amount of road opening for the installation of the new networks is to be minimized and contained within an insignificant percentage of all types of road opening daily in progress in Hong Kong.

Access to Customers

To develop genuine competition in fixed network services, all operators should be able to gain access to customers who are *directly connected* to their respective networks.

In Hong Kong, most offices and homes are located within multi-storey buildings. The individual units within the buildings are served by "common parts" which include basement, carparks, lift lobby, cable risers, corridors, etc. All network operators are given a statutory right of access to the "common parts" of buildings to install their wiring within the buildings. The developers are not allowed to obstruct the entry of the operators. The operators are however not authorized to intrude into the privacy of the residents in the buildings. They are just authorized to gain access to the "common parts" of the buildings (which are shared or "non-private" areas) in order to install their networks so that they are ready to respond to the requests for service provision from the customers in the buildings.

In Hong Kong, most people live in multi-storey buildings. HKTC in the days of the monopoly, have installed and own the in-building wiring leading to the customers' premises. The TA has issued a building access guidelines encouraging developers to provide and operate wiring for telecommunications in new development. The concept is the provision of one set of in-building wiring to which the four operators may be connected.

Apart from installing their own cables leading into customer premises, there are two other methods whereby the operators may reach their directly connected customers. An operator may lease the existing cables of another operator. Alternatively, an operator could seek what OFTA has called "Type II" interconnection.

In the so-called "Type I" interconnection, interconnection is between exchanges of the interconnecting networks (figure 1). In the "Type II" configuration (which in effect is interconnection at local loop level) the point of interconnection can be any one the points A, B or C along the local loop connected to the customer (figure 2). For interconnection at point A, the operator seeking to gain access to its customer needs to lay its cable to the local exchange of the interconnecting operator. For interconnection at point C, the operator seeking access need to lay its cable to the basement of the building where its customer resides. The operator gaining access to the customer through the local loop provided by another operator of course cannot expect to use the local loop free of charge. The operator providing the local loop is entitled to an interconnection charge based on the reasonable relevant costs incurred in providing the loop.

Sharing of Facilities

The licences issued to the local fixed network operators include conditions under which the operators are required to share "bottleneck" facilities. After considering a number of factors relating to public interest aspects of the sharing of the facilities, the TA may direct the sharing and the determine the apportionment of costs for the shared facilities. There are many types of "bottleneck" facilities. Certain ducts along roads may become "bottleneck" facilities if there are practical limitations in opening up the road to lay new ducts. Space in the buildings for access to customers may be restricted. Hilltop telecommunication sites and equipment rooms in exchange buildings may be "bottleneck".

Regulation of Prices

The regulatory regime adopted is one of regulation of the dominant operator. If an operator has lost its dominance through market development, certain regulatory oversight over the operator may be lifted. HKTC is still the dominant operator in the supply of local fixed network services. The company has the universal service obligation and may be the only suppliers to consumers at certain locations. The prices of the services of HKTC therefore need to be controlled by the Government despite the introduction of competition. The prices of the competitors of HKTC are not regulated because they are not in a dominant position. They are just required to publish their tariffs and notify them to the TA. However, as the prices of the dominant supplier

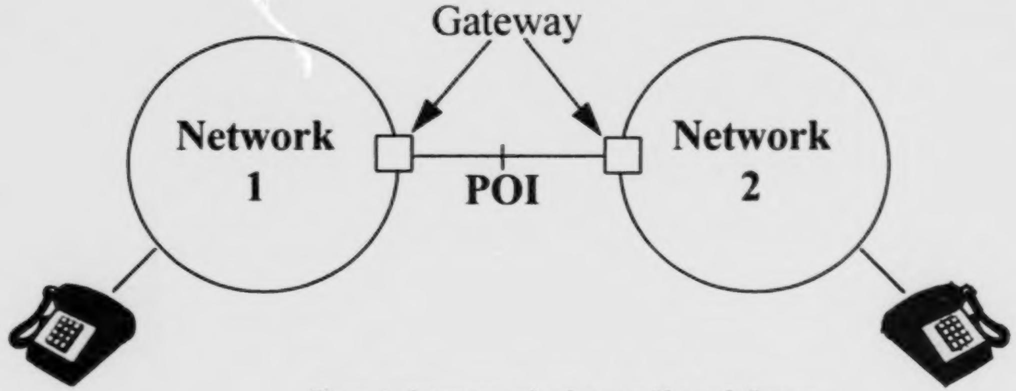

Gateway
Network 1
POI
Network 2

Figure 1. Interconnection between Network Gateways

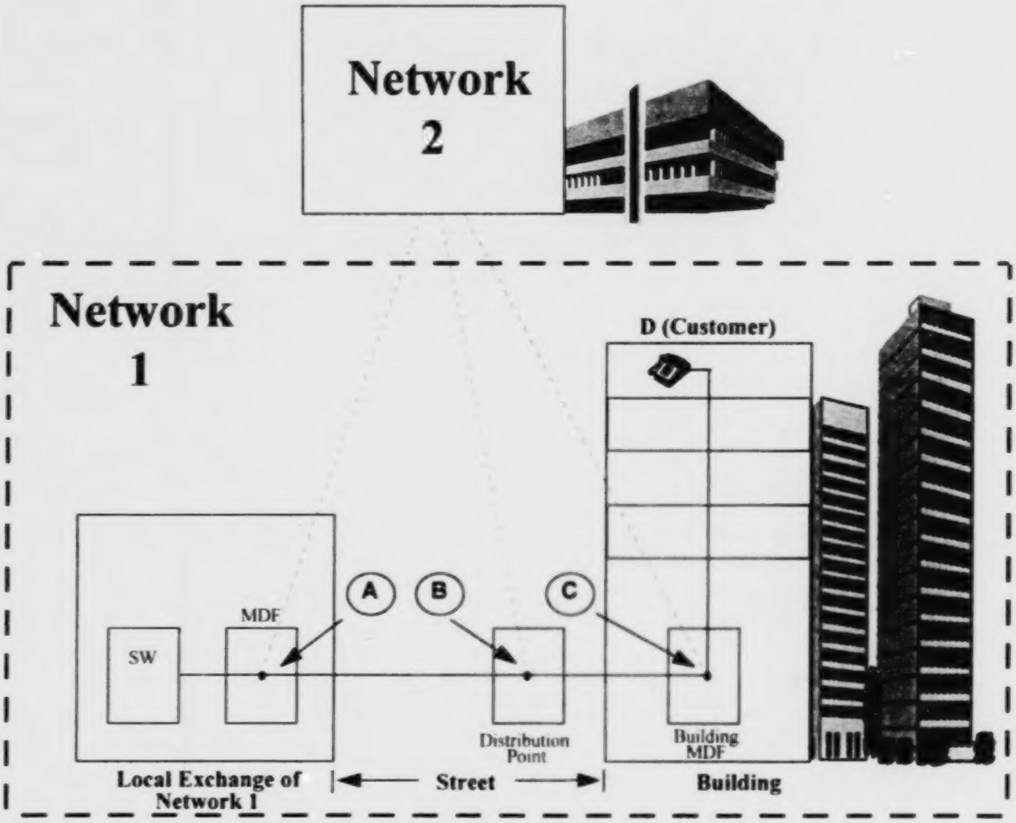

Network 2
Network 1
D (Customer)
MDF
SW
A
B
C
Distribution Point
Building MDF
Local Exchange of Network 1
Street
Building

Figure 2. Interconnection at Points in the Local Loop

are controlled, the prices of the non-dominant operators would be indirectly controlled through market-forces.

Another significant difference between the regulation of the dominant operator and the non-dominant competitors is that HKTC is obliged to charge the customers exactly as the approved tariffs. HKTC is not allowed to offer discount without obtaining approval from the TA and publishing the discounted rates. On the other hand, there is no control over the discounts offered by the non-dominant operators.

Accounting Separation

To promote fair competition in the market, any cross-subsidization between services of the dominant operator has to be monitored by the regulator. Of particular concern is possible subsidization in the service sectors where there is keen competition from the sector where there is little or no competitive pressure. To enable such monitoring to be carried out, the dominant operator is required to maintain and report separate accounts for different service segments in accordance with an Accounting Manual issued by the TA.

Competition Safeguards

As yet, there is still no fair trading legislation in Hong Kong. It is therefore necessary to include in the licence issued to the FTNS operators conditions prohibiting anti-competitive behaviour and abuse of dominant position. Conducts such as predatory pricing, price discrimination, etc. have been specified under the licence conditions to be anti-competitive if they have the effect of preventing or substantially reducing competition. Apart from monitoring by the regulator, feedback from operators proves to be invaluably useful in helping the TA to police the market.

Indirect Access

The TA has allowed a regime called "indirect access" whereby customers connected to one network would be able to access the services connected to the other networks. This includes the services provided by the other networks for access to the international gateway. All local fixed networks are connected to the international gateway of HKTI. Each local fixed network operator is assigned a short access code "00X" where "X" is a number from "6" to "9". When a customer connected to a particular local fixed network (say, network A) dials the access code of another local fixed network (say, network B) (instead the normal access code "001" or "002"), his outgoing international call will be routed by network A, through the interconnection between network A and network B, to network B and then to the international gateway. In the routing of telephone calls to the international gateway, a local fixed network operator is entitled to share part of the revenue from the international services for both outgoing and incoming calls. In the indirect routing of an outgoing call described above, network B will share in the international revenue arising from the outgoing call. This provides an operating margin whereby the operator of network B can offer the customer (directly connected to network A) cheaper rates for the international services indirectly accessed. This provides consumer choices in the routing of access to international services. Some form of competition in prices is thus created for making outgoing international calls without infringing the exclusive rights of HKTI.

In the above example of "indirect access", network B needs to identify the calling customer connected to network A. The TA has directed that all fixed operators should pass calling line identifications to the other operators in interconnection. Without such idenfications, users of "indirect access" services will have to be authenticated through awkward personal identification numbers (PIN) which are not welcomed by customers.

CURRENT STATUS OF THE COMPETITION

The new operators have received their licences in June 1995 and are now actively planning and installing their networks. Under their licences, they have obligations to provide coverage to a specified number of buildings in specified areas by specified dates. They are bound to honour these commitments by a performance bond. The new operators have installed or are planning to install optical fibre backbones through the tunnels of the Mass Transit Railway (MTR) which thread through the major commercial areas in urban areas of Kowloon and Hong Kong Island. From the MTR stations, optical fibres are to be laid to commercial buildings and selected residential buildings. Access to other buildings may be through Type II interconnection with the HKTC network. The interconnection with the local loop of the HKTC network is a controversial subject and OFTA is currently engaged in a determination proceedings for such an interconnection.

Before a substantial network is in place to reach their directly connected customers, the new operators are building a customer base through indirect access services, personal numbering and calling card services.

CONCLUSION

This paper has given an outline of the regulatory environment for the development of competition in local fixed networks in Hong Kong. Competition in local fixed market is still a relatively new development in the regulatory scene. Hong Kong has to learn from the experience of other markets. There are also some unique Hong Kong problems which need Hong Kong solutions. The TA firmly believes that the current regulatory policies and measures in Hong Kong are generally in the correct direction. Applying these policies in a fair and firm manner would ensure that Hong Kong will continue to be served by a world class telecommunication infrastructure supporting Hong Kong as a regional financial and commercial centre into the next century.

Further Information: Further information on the regulation of telecommunications in Hong Kong can be obtained from the OFTA Home Page on the Internet at URL "http://www.ofta.gov.hk".

Local Number Portability - The Promises, And The Reality

Mike Heller
Tandem Computers
Cupertino, California USA

1. ABSTRACT

Local Number Portability (LNP), which allows telephone customers to retain their local telephone number when changing to the services of a different carrier, has received relatively little attention to date outside of the United States, where the topic is being actively pursued. Other countries, such as Hong Kong, Japan, Singapore, and Australia, are now finding they are involved as well. The author outlines the various customer advantages of LNP (along with the not-so-often mentioned disadvantages), discusses technical alternatives for implementation, reviews regulatory and administrative aspects, and models a possible solution for an operator with a network of several million lines.

2.0 INTRODUCTION

As soon as customers learn they have alternatives to the telephone company for their local service, the idea of "taking their telephone number with them" if they change carriers will occur to many of them. In this paper today, we will explore the whole topic of Local Number Portability (LNP), what's known to date, and some of the as-yet unresolved problems. Telecom operators will find in this paper the answers to the key LNP questions *before* their customers ask them!

2.1 OUTLINE OF PAPER

First, let's outline the topics covered in this paper. We'll start with a definition of LNP, both its most common usage and others, discuss the advantages that LNP can bring, point out the drawbacks (and for both of these, and note who usually benefits or pays in each case. We'll talk about telephone numbering, an often forgotten detail of telephone networks, and how LNP affects the supply of numbers. Several proposals have been advanced for how to provide LNP, and we'll comment on the pros and cons of each. We'll circle the world, mentioning most of the places where LNP has become an issue, trials are proposed, etc. We next will take a hypothetical Pacific Rim telephone company operating around 2 million lines, and look at some details of how they might implement LNP.Finally, we'll discuss the various issues of a regulatory and administrative nature, and compare them with the technical problems.

3.0 LNP DEFINED (Figure 1)

So what is Local Number Portability? This subject has come up because in a variety of places around the world the idea has arisen of introducing competition into the local telephone exchange business. (For example, as of late 1995, in 46 of the 50 states in the U.S., competitive local telephone service providers are allowed.)

- **The ability of a local telephone service customer to "take the number with them" if they change local service operators**

Figure 1 Local Number Portability Defined

This has moved the question of telephone numbers to the 'front burner.' Some might point out that cellular operators (and some times cable TV operators) have provided an alternative to the local telco for some time. Since users of such services immediately see them as entirely different, the idea of having a different telephone number if you use them hasn't seemed so strange. But when a new carrier proposes to offer the same services the local telephone company does, differing perhaps only in price, the question comes clearly into focus. Changing to a different telephone number is clearly a hassle, if not a worse problem, so many users feel it's too much trouble. Thus, to more easily attract customers, the new operator raises the issue with the regulatory body: why does the traditional telephone company get to "own" the telephone numbers? Why not let the user keep his number, and "take it with him" if he decides to use the services of a new carrier?

In the rest of this paper we will concentrate on this meaning, but as Figure 2 shows, let's also remember that the same idea can apply to changing services while staying with the same operator, or to changing locations, to a different exchange, for example.

- **Can also refer to keeping the same number**
  - **When changing service types (such as from a mobile service to a wireline network service),**
  - **Or, when retaining the same service and carrier, but changing location (e.g., to a different exchange)**

Figure 2 Local Number Portability Defined

4.0 LNP ADVANTAGES

At the end of the day, LNP is only valuable if it benefits the users of telephone service. (See Figure 3.) With respect to operator portability, this means that the ability to easily switch to the services of a new carrier would be expected to bring about more choices, better service, lower costs, etc. It's no surprise, then, that the proponents of LNP are usually the new competitive local carriers (and / or regulatory bodies promoting competition). The main advantages for a country to implement LNP, then, is simply to foster competition in local services, and thus hopefully benefit the users. Any user may find it inconvenient to change telephone numbers, notify friends, etc., but businesses especially can realize concrete cost savings in avoiding the need to reprint stationery and business forms, change signs, advertising, etc. which list the old telephone number.

- **Eliminates major barrier to success of competitive carrier**
- **Reduces need for reprinting stationery, business forms, etc**
- **Eases advertising and promotion**

Figure 3 LNP: The Advantages

Of course exactly *how much* benefit LNP brings to local service competition is open to debate. Pacific Bell in California, for example, has commissioned a study which reports that, while LNP is certainly considered important by users, a lower price (and degree of bundling of services offered) is the *most* important.

- **Network and SCP costs**
- **Feature interaction**
- **Administrative effort**
- **User confusion on "toll" charges**

Figure 4 LNP: Problems And Drawbacks

5.0 DISADVANTAGES

Figure 4 lists some major disadvantages of implementing LNP. Perhaps the most obvious are the costs incurred by the telephone industry. These costs include new equipment specific to LNP, but the introduction of LNP may advance other costs as well. (In the United States, only about 75% of all local lines are served from switches already equipped with SS7 signaling, and the rest may have to be upgraded or replaced.) Whenever there are costs, the logical follow on question is who will pay them. On this point, anyway, the existing carriers and new carriers have exactly the same idea: *some one else should pay!* This has, as one would expect, become one of the major topics for regulatory body debate in areas where LNP is being considered.

Depending upon exactly how LNP is implemented, there may be other problems, some of a more subtle nature. For example, some alternatives may result in added delay in completing calls. There are a variety of telephone services that, in one way or another, rely upon the telephone number for successful operation. Billing is an obvious concern, but consider also how services that screen incoming calls, or change their routing, based on the originating number could be affected if changes were made in ways that did not consider these secondary effects.

Last, of course, comes the costs of administratively making changes, updating records and databases, etc. Fault reporting and testing might be complicated, as well. But in the end, practically all of these issues again come down to cost.

6.0 TELEPHONE NUMBER ROLES

The basis for many of these problems is the fact that telephone numbers have traditionally served two different functions. The more obvious, of course, is identifying the customer, as in "look in the directory and find the number." Less obvious to most people is that the telephone number (at least the first part of it) also uniquely identifies a physical location. (See Figure 5.) This latter use has two aspects as well. First, it is used within the network to determine where a call to a particular number should be routed.

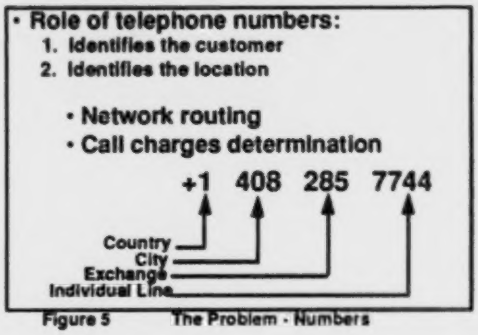

• Role of telephone numbers:
1. Identifies the customer
2. Identifies the location
• Network routing
• Call charges determination
+1 408 285 7744
Country
City
Exchange
Individual Line

Figure 5 **The Problem - Numbers**

In the United States, for example, all telephone numbers beginning with Area Code 415 are for lines - and thus customers - located somewhere near San Francisco, California; all telephone numbers within Area Code 415 that have the prefix 542 are located in a particular 20-block area in downtown San Francisco; all telephone numbers beginning with country code 44 are located in the U.K., etc.

Because a telephone number is linked with a physical location, it also forms the basis for the rating of telephone calls. Again, there are two perspectives to this, one internal to the telecom operators and one for users. Most, if not all, existing billing systems rely upon tables that relate the originating and terminating telephone numbers to the appropriate per-minute rate or equivalent. Today, for example, the charges for a call to *any* 415-542-number are the same. If all 415-542-numbers are *not* in downtown San Francisco, however, this simple approach will no longer work. (This problem of course relates mostly to geographic portability.) Another potential drawback, at least to some users, will be the "errors" introduced into telemarketing databases which, until now, have been able to draw inferences about a caller from his telephone number (by comparing the *location* of that number with demographic data) - such as guessing a caller whose number is 213-273-1234 is fairly well off, since all 213-273-xxxx numbers are in Beverly Hills.

Most users immediately know that a long distance charge will apply for calls to numbers "outside their area," and the first part of a number is the key to knowing *where* the number is located. This means that if a person were able to move to a different exchange or city, and keep their telephone number, this "location identity" for callers would be lost. (An example of this in reverse, but that illustrates the same point, is the great success of Freephone or "800" numbers; because of this unique and well advertised "area code," callers *know* that they will incur no charge for the call.)

Cellular and other wireless services may be another potential problem, since the unique numbers used today signal the nature of the service to callers. In addition, billing issues may arise, since in some jurisdictions, the wireless user pays airtime charges for both outgoing *and* incoming calls.

7.0 ALTERNATIVE LNP IMPLEMENTATION TECHNIQUES

- **Use two (or more) numbers**
  (By, for example, using call forwarding from the *original number* to a *second* [but not publicized] number)
- **Use a Service Control Point (SCP) database to convert dialed telephone number into routing information**

Figure 6 **LNP Alternatives:**

To achieve LNP, there are several alternatives, as listed in Figure 6. Several trials are using Call Forwarding, so a call directed to a customer's telephone number is routed to the original switch, where it is forwarded on to a second (unpublicized) number in the new carrier's switch. This approach, and several similar ones, while quick to implement, has a number of drawbacks. First, it uses two telephone numbers, the *real* one, plus the unpublicized one at the exchange of the new carrier. Since telephone numbers are in limited supply in all but the smallest of countries, this aspect alone makes this approach workable only in situations where few people take advantage of LNP. A second set of problems stems from the fact that the customer's line now actually has a new telephone number, even though it isn't publicized; billing systems are confused, and services that rely on the *number* of a particular line (such as Calling Line ID, or Selective Call Waiting) don't always function properly.

There is general agreement that the only viable long-term solution is in the use of the Intelligent Network architecture, using Service Control Point (SCP) databases (Figure 7). The switches recognize the need for routing instructions for the number, launch an SS7 query to the SCP, and get back the information on which switch (or carrier) is serving that customer (and number) now. This general concept has been in use in the United States for several years, providing portability for "800" numbers between carriers. Bell Communications Research (Bellcore), the R&D organization owned jointly by all the Regional Bell Companies in the U.S., has stated that they believe a single national database, such as that used for the "800" service, is not suitable for LNP implementation in the U.S., and that multiple local databases will be required.

- **Widely agreed as best long-term solution**
- **Proven in implementation of "800" number portability in U.S.**
- **Key issues:**
  - **How centralized should the SCPs be?**
  - **Do all calls require a database "dip," or only some ?**
  - **What information does the database return to the switch ?**
  - **Who owns and operates the SCPs ?**
  - **Is a SMS needed, and who operates it?**

Figure 7 The SCP Alternative

8.0 SCP IMPLEMENTATION ISSUES

There are several issues yet to be decided on the SCP alternative as well. The size (and cost) of the SCPs and connecting SS7 data link networks is directly related to the volume of queries (or database "dips," as they are frequently called). nature of the response the switches receive from the SCPs Another question is the exact. Several proposals have been advanced on this point, as well as on the question of whether the switches would need to query the SCP on *every* local call, etc. (Some of these plans appear superior in the long run, while others may be easier - or cheaper - to implement initially. AT&T and MCI recently reconciled their competing proposals, but general agreement hasn't been reached in the industry.) And of course, in a multi-carrier environment, who will own and operate the SCPs?

- **Normal telephone number format:**
  - **Exchange Identification Code substituted for prefix**
  - **"Lead" NXX Prefix for terminating office**
- **Other formats:**
  - **Carrier Identification Code**
  - **SS7 Point Code**
  - **Arbitrary routing digits**
  - **Other ?**

Figure 8 What SCP Returns To The Switch

Referring to Figure 8, the SCP response can be either in the format of a normal telephone number, or something entirely different, but obviously all carriers in a given area must agree. In Hong Kong, for example, the regulatory body has assigned each carrier a three-digit identification code, and the SCP will return this code plus the original directory number.

9.0 LNP IMPLEMENTATION REQUIREMENTS (Figure 9)

- **Supports operator portability first; service and geographic later**
- **No impact on non-moving customers (e.g., no changes in number formats or dialing procedures)**
- **Little or no effect on other services (e.g., calling number display)**
- **No impact on billing accuracy**
- **Supports normal operator services**
- **Neutral third party administration**

Figure 9 Common LNP Trial Criteria

There are a variety of countries besides the United States where LNP discussions are well advanced. If we summarize the key LNP requirements from them all, here are some typical points. Looking over the list, you'll notice that most regulators seem to want to "have their cake, and eat it too" in the sense that they would like customers who do *not* partake of LNP (i.e., those who stay with the existing carrier; perhaps mostly residential customers) to essentially not even know anything has changed, while making LNP available to those who want it (expected to largely be business users).

10.0 CURRENT TRIALS AND REGULATORY ACTIVITY

Some of the places where LNP is in the news (see Figure 10) are already conducting trials, although most are still in the discussion stage.

- **Washington State**
- **State of Maryland**
- **State of Texas**
- **State of Ohio**
- **State of Arizona**
- **State of North Carolina**
- **State of Pennsylvania**
- **State of California**
- **Chicago area**
- **London**
- **Hong Kong**
- **Australia**
- **New Zealand**
- **Finland**
- **U.S. Federal Communications Commission**
- **New York State**
- **State of Hawaii**
- **Japan, Singapore, the Netherlands**

Figure 10 Current LNP Activity

In Washington State (the Seattle area), five competing local carriers have been licensed, and a limited trial of LNP was conducted for six months in 1995. This trial emphasized the importance of a database-type solution, as a shortage of telephone numbers in the existing Area Code has already forced the introduction of a second Area Code, with the attendant confusion and disruption to businesses, etc.

The State of Maryland granted a new competitive local carrier a license, and ordered LNP be made available by Call Forwarding or other expedients until a national plan is developed. In Texas, Teleport Communications has filed complaints about Southwestern Bell Telephone's stance on interconnection and LNP issues.

In the State of Ohio, the Public Utilities Commission is holding hearings on the topic, and in the State of Arizona, several new carriers have petitioned regulators for LNP. North Carolina's orders require some form of LNP, and the State of Pennsylvania has ordered LNP to be provided by Bell of Pennsylvania. Requests for LNP have been filed by four applicants for local carrier status in California, where Pacific Bell has already announced its cost study indicates they will want to charge someone, for each line, US$ 31.75 to establish LNP *plus* US$ 3.25 per month. (These applicants include long distance companies such as MCI, Sprint, and AT&T, as well as cable TV companies and satellite service providers.)

Ameritech, the Regional Bell Telephone Company headquartered in Chicago, issued a Request For Proposal (RFP) in February of '95, looking for a complete, SCP-based LNP solution, to go into service around April 1996. The solution is to provide for portability among operators immediately, with portability between different services and geographies to be added within two years. Ameritech is acting in the face of numerous requests for LNP, including from MCI in Wisconsin and numerous new carriers in Illinois.

In the U.K., Oftel, the regulatory agency, has studied the LNP matter at length, and concluded that a fully implemented SCP-based solution would be too expensive, given their estimates of the benefits likely to accrue. For the time being, they have directed the U.K. operators to offer number portability based on variants of Call Forwarding.

There are now four licensed wireline telecom companies in Hong Kong, and OFTA, the regulatory body, has ordered LNP to be put into effect. A specific plan has not yet been agreed upon, however, between HK Telecom and the new operators regarding the method to be used, how the costs would be borne, etc.

Australia and Finland are planning to introduce number portability, likely starting with Freephone ("800") services before tackling the tougher local numbers. An interconnection agreement between Telecom and Clear Communications has been reached in New Zealand which doesn't initially include LNP, but undoubtedly will soon. Singapore, Japan, and the Netherlands, who either already have competitive carriers or are actively planning for them, have begun studies of LNP.

Back in the U.S., the Federal Communications Commission, perhaps feeling it was falling behind all the activity in the various states, has launched a proceeding to develop a "uniform, national method for providing number portability." It noted special concern that any LNP arrangements put in place be able to support both normal operator services and emergency services such as "911." It has also noted that the demand for LNP, as well as the cost issues, may be quite different in rural regions than in the major metropolitan areas.

New York State requested proposals from vendors to implement a one-year trial (beginning February 1996) of LNP in two areas, one in

Manhattan, the business part of New York City, and one in Rochester, a smaller town in upstate New York. They are especially concentrating on proving that an SCP-based solution is effective, and that the administrative issues can be resolved. (Tandem Computers is one of the vendors involved in these trials.) NYNEX, the local telephone company in New York City, has already reached an agreement on interim LNP with several new local service carriers.

It's interesting to study a customer survey on LNP conducted by the New York State Public Service Commission. Most said they would like to keep their number when changing to a different carrier, and would even be willing to pay a *reasonable* fee to do so, with 'reasonable' being higher for business customers. Many also expressed the view that users should be able, for a higher fee, to *buy* a particular number, much as one can often do with an automobile registration plate. On the question of geographic portability, most respondents thought it was reasonable to change numbers if you moved (indeed some thought it was a obvious and desirable *mark* of their move, especially if they moved to a nicer neighborhood), but that numbers should, in any event, *not* be movable beyond the local exchange calling area.

And before moving on, right here in Hawaii a new law enacted last summer requires the PUC to set up appropriate conditions and guidelines for competition in the local exchange service market. The law calls for LNP "as soon as technically feasible and economically reasonable" (which is now, as you'll see shortly).

11. A MODEL TELEPHONE COMPANY EXAMPLE

In our model Telco example, we consider the situation of a telephone company of about 2 million lines and typical traffic characteristics (see Figure 11).

- **2 million access lines;**
  50 exchanges (40,000 lines / exchange)
- **ABD BH Calls per line = 1.3**
  (4.0 ccs/line with 5 min. average call length)
- **85% of originated calls are local**
- **Incoming toll calls = outgoing toll calls**
- **SS7 links operate at 64 Kb/s @ 40% occupancy**
- **LNP database at single SCP pair**
- **ALL local numbers are checked [worst case]**

Figure 11 Model Telco: Case Study Assumptions

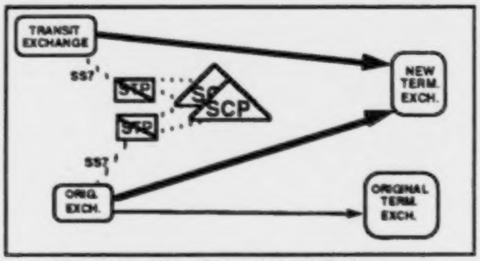


Figure 12 Model Telco: Network Design

- **SCP Transactions Per Second:**
  2 m lines * 1.3 * 85% / 3600 = 614 (local calls)
  + 108 (incoming toll) = 722 = 361 tps / SCP
- **SCP database:**
  2 million lines * 100 bytes = 200 MegaBytes
- **SS7 data links at each SCP = 12**

Figure 13 Model Telco: Network Sizing

Our design is deliberately somewhat simplistic, with our objective being to illustrate that, even under this "worst case" scenario, implementing a SCP-based LNP network is quite practical, and not exorbitantly costly. The design and sizing shown here (Figures 12 and 13) assumes there is a pair of SCPs and a single SMS which will be the master database, downloading updates and changes to the SCPs. In practice, each local carrier (and perhaps long distance / international carriers) might each want to have pairs of SCPs of smaller size. The choice of whether to use an SMS or not depends upon the number of SCPs involved as well as the number administration agreements between the carriers (i.e., who would own and operate the SMS?). When the number of SCPs is large, and there is an agreeable "neutral third party" to operate it (and a mechanism to compensate them), it can be very efficient. (In the example of 800 number portability in the U.S., for example, a single SMS is the master database for over 50 SCPs scattered around the country.) As can be seen in Figure 14, the initial costs for the computer systems would be be US $3 to $5 per line, suggesting monthly costs per line of around 25 cents U.S.

Estimated initial cost, installed in a Pacific Rim country:

Two SCPs:	**US$ 5.9 million**
One SMS:	**US$ 2.6 million**
Total:	**US$ 8.5 million**

Note that the local SS7 network (STPs, SS7 Links, and SS7 frames in local switches) may also require expansion, although the extent and cost of this cannot be determined except with a detailed analysis on a case-by-case basis.

Figure 14 Model Telco: Initial Costs

There is yet another reason why our sizing and costing may be high. Some of the techniques proposed for SCP-based solutions would require the switches to look in the database only for some calls, rather than for all, as we have assumed here. This table (Figure 15) illustrates the sizable reduction in costs if not all the local calls require a database "dip."

	Incoming toll calls: dips per second	Local calls: dips per second	Total dips per second to SCPs	SCP Load
100	108	614	722	100%
75	108	461	569	79%
50	108	307	415	57%

Figure 15 Model Telco: Effect Of Selective Database Lookup

12.0 REGULATORY AND ADMINISTRATIVE ISSUES

- **Who "owns" telephone numbers ?**
- **Who will own and operate SCPs ? (And SMS, if used ?)**
- **How will assignment of new numbers be accomplished ?**
- **How will customers indicate they want to change carriers ?**
- **What coordination between carriers will be needed to insure one, and only one, network location exists for each telephone number at every instant in time**
- **How will problems and database errors be resolved ?**
- **Will numbers be returned to original network upon disconnect ?**
- **Who will pay for the LNP databases and administration costs ?**

Figure 16 Regulatory And Administrative Issues

As has been seen, the technical ability for databases to handle the query volumes required by LNP is at hand today, and the costs of implementation would not be exorbitant. More difficult questions to resolve (see Figure 16) concern issues such as who owns the telephone numbers (and the related question: who assigns them to customers?) Will each company need to have SCPs? (The established carrier probably already does; the new entrant will resist the cost.) How would a customer actually change carriers? If the customer signs up with a new carrier, how does the old carrier learn of the planned change, and how is the actual cutover coordinated? If the change, for some reason, doesn't work properly, to whom should the customer complain? And what will that party be able to do about it? If a customer moves his or her service (and number) to a new carrier, and then disconnects that service, does the new carrier keep the telephone number, or must it be returned to the originating carrier? If an SMS is used as a "master database," who will own and operate it?

13.0 CONCLUSIONS (Figure 17)

In conclusion, I've tried to cover the pros and cons of Local Number Portability, outline some of the issues involved in implementation, and show, for a hypothetical telco of some 2 million lines, what implementation would involve and might cost. As competition enters into more and more aspects of telecommunications, the ability of customers to *easily* choose their service providers will become increasingly important. And Local Number Portability eliminates one of the largest barriers to such changes being easy. There are no real technical barriers to implementation; only policy and administrative ones to be made by the regulators. LNP is truly an idea whose time has come!

- **Local Number Portability is practical *now***
- **Database approach is superior to Call Forwarding or other "interim" alternatives**
- **Costs are not excessive, but key issue is their allocation between established and new carriers**
- **Biggest difficulty in implementing LNP is likely to be policy and administrative processes**

Figure 17 Conclusions

Telemedicine and Telehealth in the Pacific Islands Region: A Survey of Applications, Experiments, and Issues

Steven D. Bice,[i] Greg Dever,[ii] Lori Mukaida,[iii] Scott Norton,[iv] and Jimione Samisone[v]

[i]Policy Analyst, U.S. Public Health Service, San Francisco, U.S.A.
[ii]Director, Medical Officer's Training Program, Pohnpei, FEDERATED STATES OF MICRONESIA
[iii]Director, PEACESAT, University of Hawaii, U.S.A.
[iv]Chief of Dermatology, Tripler Army Medical Center, Honolulu, Hawaii, U.S.A.
[v]Dean, Fiji School of Medicine, Suva, FIJI

1. ABSTRACT

"Telemedicine" and "telehealth" are promising and important applications of the revolution in telecommunication and information technologies. These applications, for the most part, will be based on inexpensive broadband telecommunication and information networks, which in the next 10 years, will be "ubiquitous" in developed countries. These applications, however, are not certain for lesser developed countries that may only have access to narrowband telecommunications, even though there are significant experiments in telemedicine and telehealth in the Pacific Islands Region. The purposes of this paper are to: (a) broadly describe telemedicine and telehealth and review some of the emerging applications; (b) discuss some of the experiments that are being conducted in the Pacific Islands Region; and, (c) identify some of the issues and questions that have emerged at the forefront out of the experiments with Pacific Islands Region telemedicine and telehealth.

2. INTRODUCTION

Telemedicine and telehealth are the emerging medical and health applications of telecommunications and information technologies.(1) Telemedicine applications are those directly related to medical applications and treatment. Telehealth applications are focused more on the holistic health related programs defined generally by practitioners in public health. Both rely heavily on the use of distance education and learning technologies.

Telemedicine applications use audio, text, image and video through computer, facsimile, scanners, camera light box, cameras, multi-media, electronic mail, remote monitoring systems, video conferencing, and other associated technologies to enable the delivery of medical care as an attempt to lessen the gap between the availability of expertise and services at remote locations. Some of the medical and support services of these technologies include:

- medical consultation;
- diagnostics;
- CAT scan, electrocardiogram, x-ray, and ultrasound data transmission and interpretation;
- patient transfers/referrals;
- medical records transfer;
- transmittal of prescriptions and doctor's orders;
- medical database access;
- general administration;
- research links;
- central data collection and organization;
- retrieval of medical literature;
- continuing education for doctors, nurses, and other medical personnel; and,
- training.

Telehealth, as a complement to telemedicine, uses many of the same technologies as telemedicine but focuses on the holistic treatment of medical and health needs. "Telehealth" encompasses the larger concerns involved in both public health and medical care. Some of the telehealth applications supported by these technologies include preventive

709

programming, education and training for health care providers, medical staff, patients and the community in the following areas:

- prevalent health problems and promotion of methods of prevention and/or control;
- personal health care and proper nutrition (wellness programs);
- promotion of environmental concerns, especially for an adequate supply of safe water and basic sanitation;
- maternal and child health care, including family planning, pre-natal care and well child care;
- immunization against major infectious diseases;
- prevention and control of locally endemic diseases;
- appropriate treatment of common diseases and injuries; and,
- training in and provision of essential life saving therapies (drugs to control hypertension, insulin for diabetes, etc).

Telecommunications can assist local physicians, health care givers, policy and decision makers to: (a) reach out to their communities (b) acquire a better understanding of basic primary health care goals, and (c) discuss and analyze appropriate interventions. In essence, the term "telehealth" connotes the use of telecommunications technologies for the enhancement of the health of a population, and does not limit that use to medicine alone.

3. TELEMEDICINE AND TELEHEALTH IN REMOTE AREAS

Telemedicine and telehealth applications have advanced rapidly during the past five years and may have a significant, practical impact on *improving the delivery of medical and health care* in remote areas that suffer from isolation, small size, sparse and dispersed populations, a limited resource base, and great distances. As noted by Dena Puskin (1995: 54) of the Office of Rural Health, U.S. Department of Health and Human Services, telemedicine and telehealth "have the potential to reduce the isolation of rural practitioners and patients, and facilitate integration of services across communities that individually cannot sustain a full range of health services."

Significant portions of the Pacific Islands Region populations are underserved by their health care system due to geographic and socio-economic constraints. Some of the areas in which health care systems may lack sufficient support are: (a) in the number of or the lack of physicians and/or specialists necessary to serve the population; (b) continuing education for existing health care providers; and, (c) appropriate facilities and technologies to serve their populations. Telemedicine and telehealth applications can improve Pacific Island health care systems by providing affordable, quality health care to patients, where and when they need it.

Telemedicine and telehealth may also help to lessen the *cost of services*. For example, the current practice of the U.S. affiliated countries is to evacuate patients in the Pacific Islands once a determination for critical or acute care is made. Family members are often allowed to accompany the patient. The cost of evacuation is extremely excessive and represents a large proportion of health and medical expenditures in the Pacific region. Telemedicine could conceivably help to lessen the number of evacuations and the attendant costs by assisting in diagnosing the need for evacuation and by providing remote consultation.

Further, and just as significant, are the travel costs for follow-up care. Family members are often allowed to travel with the patient even for follow-up care. By delivering health and medical services through telecommunications, the cost of follow-up care could be lessened, thereby enabling resources not spent for evacuations to be reallocated to other areas of health and medical program needs.

Certainly, there are indications that the economic condition of the '90's may require health care systems to discriminate among priorities in critical and acute care based upon available funding and resources. Delinquent hospital and medical bills in Fiji, Guam, Hawaii and elsewhere might not be tolerated. The use of telemedicine and telehealth applications should be examined as a means to improve medical and health care while reducing costs in the Pacific Islands Region.

4. TELEMEDICINE EXPERIMENTS IN THE PACIFIC ISLANDS REGION

There are several current and planned telemedicine and telehealth experiments in the Pacific Islands Region. These experiments are intended to develop a base of experience and knowledge that will help to determine the usefulness of these telecommunications applications. Since these trials are still in the initial stages of development and experimentation, it is far too early to determine their long-term programmatic value and costs.

These trials are further important to: (a) assess the needs within communities, which vary significantly across the region; (b) identify cultural and other issues with the introduction of such services; and, (c) identify other barriers and problems that might affect the usefulness of these applications in the region. These experiments in telemedicine and telehealth applications may provide the base of experiences that will lead to substantive, appropriate services and programs to promote health, increase medical responsiveness, and lessen the costs of providing these services and programs in remote island environments.

4.1 TRIPLER ARMY MEDICAL HOSPITAL AND KWAJALEIN MISSILE RANGE HOSPITAL

One of the first experiments in the Pacific Islands Region was initiated by the Tripler Army Medical Center (TAMC) located in Honolulu, Hawaii. The TAMC Telemedicine Program was originally developed to support the hospital services at Kwajalein Missile Range (KMR) Hospital in the Republic of the Marshall Islands. The TAMC uses a Department of Defense T-1 link between TAMC and Kwajalein for video-based teleconsultation twice a month between doctors and patients. Results of experiments demonstrate that TAMC has had a significant impact on the number of medical referrals by the KMR Hospital.

Adjacent to Kwajalein is Ebeye which supports a dense population of 14,000 on an atoll comprising less than two square miles. Since medical conditions are unsatisfactory on Ebeye, patients on Ebeye are also seen through teleconsultation under TAMC's mandate to provide specialty care to the Republic of the Marshall Islands.

Over the past two years, more than 200 teleconsultations in 23 specialties have been conducted. The TAMC telemedicine program provides the means for intervention before the condition of the patient deteriorates to the point of requiring costly referral and evacuation.

The initial goals of the TAMC telemedicine program are to provide: (a) primary care services; (b) specialty consultations; (c) continuing health education programs; (d) patient and community health education; and (e) communications links among providers in the region.

In order to achieve these goals, TAMC is collaborating with the Pacific Basin Medical Officers Training Program (PBMOTP), in Pohnpei, Federated States of Micronesia (FSM), and PEACESAT. Both PBMOTP and PEACESAT are University of Hawaii programs.

4.2 PACIFIC BASIN MEDICAL OFFICERS TRAINING PROGRAM

The Pacific Basin Medical Officers Training Program, located in Kolonia, Pohnpei, was introduced to the Telemedicine Program at Tripler Army Medical Center (TAMC) in early 1994. Through experimentation with the AT&T Picasso Still-Image Phone, TAMC began to expand its telemedicine program to specific sites in the U.S. affiliated Pacific Islands in the Western Pacific.

The Picasso Still-Image Phone is a still-frame, video phone system which, when used with a video camera and a TV monitor, can digitize and transmit freeze frame color pictures of high quality over regular telephone lines. The Picasso Phone unit, which is the size of a desk top executive telephone, is a computer capable of storing, sending, and receiving high quality, freeze-frame color video pictures with simultaneous voice communications. The Picasso Phone unit costs under $5,000 and certain models have battery storage capacity to insure against loss of picture memory due to power failures. Connected to a camcorder, a TV monitor, and a dedicated telephone line, the unit is user friendly and operates much like a VCR.

4.2.1 PACIFIC BASIN MEDICAL OFFICER TRAINING PROGRAM EXPERIMENTS

Since 1994, the Pacific Basin Medical Officers Training Program has participated in and has documented the following telemedicine experiments:

- At the Charter Meeting of the Pacific Basin Medical Association (PBMA), April 3-5, 1995, in Pohnpei, the TAMC Telemedicine Program team gave two demonstrations using the Picasso Phone to over 75 participants of the meeting: (a) a patient consultation from Pohnpei to the Republic of Palau, which assisted in the prevention of a costly, off-island referral, and (b) a lecture from TAMC in Honolulu to the PBMA conferees on Pohnpei regarding "HIV in the Pacific - 1995."

  Facilitated by TAMC, AT&T donated four Picasso Still-Image Phones to the region. PBMOTP (Pohnpei) received 2, Kosrae State Hospital (Kosrae) received 1, and PEACESAT (Headquarters, Hawaii) received 1. Since then, other demonstration activities have been documented using the Picasso Still-Image Phone for teleconsultation and distance learning.

- PBMOTP Weekly Director's Rounds and Lectures have been teleconferenced with participants in the PBMOTP campus in Pohnpei, the Pohnlangas Dispensary (a 2 hour drive from Nett, Pohnpei), and the Kosrae State Hospital (KSH) which is 45 minutes away from Pohnpei by air;

- Teleradiology experiments involving teleconsultation over pediatric x-rays between PBMOTP, Pohnpei, and TAMC, Honolulu, have been initiated. PBMOTP pediatricians present problematic x-ray films over the Picasso Phone system to pediatric pulmonologists at TAMC. Pohnpei is nine hours away from Honolulu by air, separated by three time zones, and the International Date Line.
- PBMOTP has also documented emergency telemedicine applications. For example, KSH physicians in Kosrae requested emergency x-ray teleconsultation services. The PBMOTP internist in Pohnpei assisted KSH physicians in the management of a trauma patient with a hemothorax.
- At the Annual Waianae Primary Health Care Conference held on Oahu, Hawaii, in which 146 representatives from the Community Health Centers of Hawaii and the Pacific Islands participated, there were two telemedicine demonstrations from Pohnpei and Palau: (a) the PBMOTP Associate Director lectured from Pohnpei to the Waianae Conference on the "Management and Treatment of Leprosy," and (b) Dr. Victor Yano, President of the Pacific Basin Medical Association, and Dr. Stevenson Kuarte, the Medical Director of the Palau Community Health Center spoke from the Republic of Palau to the Waianae Conference participants about integrating telemedicine into the Pacific health care system.
- On July 7, 1995, the PBMOTP Director lectured from Pohnpei to the Western Alaska Telemedicine Conference in Nome regarding "Telemedicine Demonstration Projects in the Western Pacific." The Alaska audience included senior representatives from the following organizations: Indian Health Service, Alaska Native Medical Center, the U.S. Air Force, Native Health Councils, Alaska Regional Health Agency, the Alaska Telemedicine Project at the University of Alaska, and the TAMC Telemedicine Program team.
- On July 26, 1995, the PBMOTP gave a telemedicine presentation to the 14th General Assembly of the Association of Pacific Island Legislatures on Pohnpei connecting the legislative representatives from the Pacific Islands with both the Telemedicine Program at TAMC, Honolulu, and the Kosrae State Hospital (KSH) for a brief introduction lecture on telemedicine and an x-ray teleconsultation with the staff of KSH.
- Every Wednesday, the PBMOTP supports scheduled medical teleconsultations with KSH medical staff in Kosrae. KSH physicians have the opportunity to present patients and x-rays and obtain second opinions by the PBMOTP specialty physician staff. Additionally, the PBMOTP provides mini-lectures in continuing medical education for the KSH medical staff.

4.2.2 CURRENT STATUS OF PBMOTP TELEMEDICINE EXPERIMENTS

Efforts are underway to link the Picasso Still-Frame Phone system through the PEACESAT satellite system to introduce this technology to remote Pacific Island countries supported by PEACESAT earth stations. Experimentation may then focus on the regular use of Picasso-based telemedicine applications among remote island countries and become the experimental base for the documentation and evaluation of its potential, audio conferencing and still-frame video, to benefit Pacific Island health care.

The major expense in the PBMOTP experiments has been the international transmission costs incurred. When the still-frame video phone technology is adapted to the PEACESAT Public Service Telecommunications Network, transmission cost will no longer be a deterrent in the growth of this telemedicine network. Utilization of PEACESAT's 44 earth stations in 22 countries will create a virtual geographical extension of the experiments with very few new funding dollars.

The use of the Picasso Still-Frame Phone System as a telemedicine application is an example of a relatively low cost, user-friendly, narrowband system. The system requires purchase of the phone system, access to the public switched telephone network, and/or use of PEACESAT for the remote link. Additional equipment for remote sites could be added as budgets permit.

The PBMOTP experiments in telemedicine applications have shown the utility of the system in many arenas: (a) international telecommunications between developed and developing country urban centers (Hawaii to Pohnpei, Hawaii to Kosrae), (b) telecommunications among developing countries (Pohnpei to Kosrae, Pohnpei to Palau), and (c) domestic telemedicine applications from developing urban centers to remote dispensaries (Nett, Pohnpei to Pohnlangas, Pohnpei).

4.3 TELEMEDICINE AND FIJI: THE FIJI SCHOOL OF MEDICINE

The Fiji School of Medicine (FIJI-SM) has trained well over one thousand medical officers.(2) More than one-third of the graduates are nationals of American Samoa, Western Samoa, Tonga, Cook Islands, Tokelau, Niue, Tuvalu, Kiribati, the Solomon Islands, Vanuatu, Nauru, the Republic of the Marshall Islands, the Federated States of Micronesia, and the Republic of Palau.

The FIJI-SM recently implemented a unique layer to its undergraduate medical training program. Fourth year FIJI-SM students are attached to rural health care facilities in their own communities. As an apprentice, the student receives practical, on-the-job training, and is required to undertake an applied health research project in primary health care. For this phase of training, the students come under the supervision of practicing medical officers from within their own communities who have been specifically selected and trained to be supervisors and Public Health Care tutors. These medical officers are also appointed as Honorary Clinical Instructors to FIJI-SM and, in this way, become non-salaried members of the faculty. In this context, the FIJI-SM is effectively decentralized throughout the region by the actual physical presence of students in the region and the Honorary Supervisors in those communities.

The FIJI-SM and the Fiji government have endorsed the School of Medicine as an institution of Post-graduate Training and Continuing Medical Education. The FIJI-SM is currently developing a strategic plan for the implementation of postgraduate training and continuing medical education within the region. The decentralization of FIJI-SM resources throughout the Pacific Islands in support of the undergraduate medical training program has strengthened the regional nature of the institution. Consequently, the FIJI-SM has established an enhanced human network among Pacific Island health care centers through its tutors and students which could support other cooperative and collaborative endeavors to improve medical and health services throughout the region.

The FIJI-SM is also strengthened through its affiliation with the Colonial War Memorial Hospital (CWMH), which has recently expanded and upgraded its technology and services in support of diagnosis and management of secondary and tertiary care problems. Currently, remote Pacific Island countries can not access these resources or facilities remotely.

At this time, a cost-effective telecommunications capability does not exist to support real-time, interactive voice, data, or video applications between and among the FIJI-SM and the participating Pacific Health Care Centers.

In order for the FIJI-SM to successfully implement its undergraduate medical training, postgraduate training, and continuing medical education programs, the FIJI-SM must have access to public health care constituents in the Pacific Islands region on a real-time, interactive, and daily basis. The FIJI-SM followed the PBMOTP experiments very closely, and will adapt these experiments and applications under its new Office of Postgraduate Training and Continuing Medical Education.

4.4 PACIFIC ISLAND HEALTH OFFICERS ASSOCIATION

The Pacific Island Health Officers Association (PIHOA) is a non-profit organization with members in the six Pacific countries and territories affiliated with the United States: American Samoa; the Common-wealth of the Northern Mariana Islands; the Federated States of Micronesia; the Territory of Guam; the Republic of the Marshall Islands; and, the Republic of Palau. The members of PIHOA are the principal health officials from each island jurisdiction. PIHOA is committed to improving health within the region, and focuses on health issues and special projects of regional significance.

In 1995, the U.S. Public Health Service funded a PIHOA training project to work collaboratively with PEACESAT to ensure that health personnel in the region would be able to use remote dial-in services for access to Internet electronic mail and file transfer services. PIHOA and PEACESAT have implemented this network and are examining other alternatives for improving information access and electronic mail communications in the region.

5. THE TELECOMMUNICATIONS BARRIER

One of the major barriers to extending telemedicine and telehealth applications throughout the Pacific Islands Region is the state and cost of the telecommunications and information infrastructure. In this regard, the international telecommunications and information infrastructure is viewed as an important and significant barrier in the development of telemedicine and telehealth applications. If the region is to benefit from the sharing of resources and the emerging telemedicine and telehealth experiments, the international telecommunications infrastructure must be able to support these applications.

The problem of the state and cost of the telecommunications infrastructure is not limited to the Pacific, but extends to rural communities in the United States and other developed countries as well. The barrier of the telecommunications infrastructure to telemedicine and telehealth applications is clearly stated by Dena S. Puskin of the U.S. Department of Health and Human Services. In an article describing barriers to the development of rural telemedicine systems in the U.S., Puskin notes that:

> "[t]he best designed systems still face barriers to implementation. While much has been said about building the nation's electronic highway, we in rural America are often dealing with the equivalent of the dirt road. The lack of an adequate telecommunications infrastructure is a key barrier to development of telemedicine systems in rural communities." (1995:55)

Puskin is not only concerned with the nature of the infrastructure, she is also concerned with costs. She states that:

> "Clearly, transmission costs must be lowered if telemedicine is to become economically feasible for many rural communities."

The statements of Puskin regarding the telecommunications infrastructure and costs are appropriate not only to rural areas in the United States, but also applies to the Pacific Islands Region as well.

Unfortunately, for reasons beyond this paper, the cost of international telecommunications is prohibitive and is a deterrent to more experimentation. For example, a direct dial telephone call from Honolulu to the Pacific Islands region varies from U.S. $1.20 per minute to over U.S. $2.00 per minute. The cost of a call from the FSM to Fiji is close to $3.00 per minute. These costs severely restrict the ability of health and medical organizations from sharing resources and expertise, and prohibits other countries in the region from participating in the trials.

Fortunately, in the Pacific Islands Region, there are two public service telecommunications test-beds for telemedicine and telehealth application experiments. One is Japan's PARTNERS network. Another is PEACESAT.

5.1 PARTNERS

The Japan Ministry of Posts and Telecommunications (MPT), following technical experiments on the Engineering Test Satellite-V or "ETS-V," made the satellite available for application experiments in 1989. The project was named the Pan-Pacific Regional Telecommunications Network Experiment and Research by Satellite or "PARTNERS" Project.

There are two types of network systems supported by the PARTNERS Project. Network I was designed by the Communications Research Laboratory (CRL) of MPT as a 64-Kbps digital satellite link to support video conferencing for distance learning.

The PARTNERS Network I distance education program includes the King Mongkut's Institute of Technology Ladkrabang (KMITL) in Thailand, the Institute of Technology Bandung (ITB) and LAPAN in Indonesia, the University of Technology (UNITEC) in Papua New Guinea, the University of the South Pacific (USP) in Fiji, the University of Hawaii (PEACESAT) in the U.S.A., the Communications Research Laboratory (CRL) of the Ministry of Posts and Telecommunications in Japan, the National Institute of Multi-Media Education (NIME) of the Ministry of Education in Japan, and the University of Electro-Communications in Japan.

Network II was developed by Tokai University, Japan, for the transmission of precise still pictures via an FM satellite link, making it useful for telemedicine experiments in teleconsultation and diagnoses. Network II includes seventeen hospitals in Thailand, Papua New Guinea, Fiji, and Cambodia.

After five years of experimentation, the ETS-V PARTNERS Project plans to migrate to another satellite system in 1996.

5.2 PEACESAT

PEACESAT is a Pacific region satellite telecommunication network supporting application experiments in narrowband satellite communications and international public service telecommunications.(3) Public service telecommunications is defined as noncommercial, international communication services used by educational institutions, government, medical, and other non-profit organizations to support distance education and learning, emergency management, medical and health, research, technical assistance, economic development, and community service programs.

PEACESAT uses the Geostationary Observation Environmental Satellite (GOES-2) on a dedicated basis for use by the Pacific Islands Region. This is an obsolete weather satellite with a functional, although limited, communication transponder. The

714

network may not be used for personal or commercial communications.

PEACESAT currently has 44 earth stations in 22 countries within the Pacific Basin. PEACESAT offers voice and data services, but also provides access to Internet in both on-line and batch transfer modes. The earth stations are 3m in size, have a 50W HPA, audio processor, phone patch, and analog data modem.

There are two major limitations of the network. First, the earth stations can only perform one function at a time. For example, the PEACESAT 3m earth station can be used for voice teleconferencing over a simplex circuit, voice teleconferencing over a full duplex circuit, or data communications over a full duplex circuit. However, it is not possible to perform more than one of these functions at the same time.

A second limitation is that there are only 3 full duplex circuits. This essentially means that the users must schedule data transmission time for use of these circuits.

PEACESAT has developed plans for a digital "Hub Site" network using the residual bandwidth and power of the GOES satellite which will significantly improve services.(4) Each of the Hub Sites will support multiple concurrent voice circuits, a dedicated data (28.8 Kbps) circuit, and shared use of compressed digital video circuits. These Hub Sites will use a 6m antenna, 75W HPA, and other digital compression and switching capabilities to provide a medium for the Pacific Island countries to offer and to connect to public service telecommunications programs and services throughout the region and the world.

The digital network will further enable a significant extension of the TAMC, Kwajalein, FIJI-SM, PARTNERS, PEACESAT experiments and other telemedicine/telehealth initiatives. Some of the planned health and medical users and uses of the PEACESAT Hub Site network are briefly described below:

- Medical teleconferencing using Picasso type systems or compressed digital video teleconferencing at 128 to 256 Kbps.
- Hospitals and clinics would be able to communicate with the Tripler Army Medical Center and other physicians for remote health and medical consultations.
- The Pacific Basin Medical Officers Training Program in the Federated States of Micronesia, in collaboration with the Fiji School of Medicine, the University of Hawaii School of Medicine, and School of Public Health will be able to provide continuing education to medical officers in the field throughout the Pacific Islands Region and receive instruction as well as diagnostic assistance from hospitals and other educational institutions.
- Medical officers and clinicians in the field will be able to transmit their digital image data through inexpensive dial-up devices to medical institutions located in Guam, Honolulu, and elsewhere for medical consultation.
- Public health and medical personnel will have access to Internet electronic mail, file transfer, and gopher applications through dial-up modems.
- On a scheduled basis among the countries, the public health and medical institutions and staff will have access to the World Wide Web of Internet.
- Distance learning and educational programs (e.g. seminars and workshops) will be held through one-way digital video with voice and data return.(5)

This network should be in place in 1996, providing that appropriate funding for the Hub Site technology is obtained. The Hub Sites will include American Samoa, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, Fiji, Guam, the Republic of the Marshall Islands, the Republic of Palau, and the Solomon Islands.

6. ISSUES AND QUESTIONS

The initiation of the trials in telemedicine and telehealth in the Pacific Islands Region are valuable in helping to raise questions and identify issues. Although the experiments are only in its infancy, the trials have already raised many issues and questions. The following is a brief discussion of a few of these issues and questions.

6.1 ISSUES

The following describes some of the application specific issues that have emerged during these trials.

- Language. Language has emerged as a problem among some of the sites, especially in the PARTNERS network. Working in the field of telemedicine may require considerable working knowledge of a common language such as English.
- Standards and Licensing. Does a physician have to be licensed in a country receiving the service?

If so, what are the standards and how should they be administered?

- Operational Protocols. The protocol for providing a telehealth or telemedicine service has not been fully developed. The PBMOTP teleconsultation and distance learning experiments in telemedicine applications clearly indicate a need to establish standards for operations and the need for the development of training manuals to address operations and content protocol and procedure.
- Financial Reimbursements. How should the cost of medical consultation and other services be valued and assessed across the region? Relationships and commitments for support of the Pacific Islands region are complex given the different relationships among the territories and Freely Associated States. When one adds in the complexities of other countries, the financial relationships may become extremely complex.
- Culture. Telemedicine is certainly not the only or sometimes even the best answer to medical problems suffered by people in developing countries. In fact the same kind of coordination needed to achieve success without telemedicine will be required with the technology:
  - physicians at the referral site and at the local jurisdictional hospital will need to discuss the case at some length sharing what physical findings and laboratory evaluation they have available (this will take time and patience and will often be frustrating for both professionals);
  - the follow-up or discharge planning necessary to return a patient from a referral hospital to a hospital set in a developing country will be required in the future as it is today (and just as it is not always done today, technology will not ensure that it will be done tomorrow);
  - the local customs and traditions will play as large a part in medical interventions with telemedicine technology in the future as it does today. And the providers of care at the referral or consultation site must endeavor to understand these customs/beliefs today and in the future.
- Appropriate expenditures. Should funds be allocated to the purchase of the telecommunication and information technologies or should they be used in other ways?

There are many other issues that should be examined, including, but not to be limited to: professional and/or educational level of medical organizations and individual physicians providing services through telecommunications; ethics and standards; reimbursement; liability; application of insurance benefits; and inter-cultural and inter-personal perspectives. These issues suggest a need for a parallel research effort into the many social, economic, and policy issues raised in telemedicine and telehealth. Unfortunately, the extent of these studies will be constrained by many of the same barriers of funding, distance, cost of telecommunications, and so on.

6.2 QUESTIONS

As with many application experiments in telecommunications, the initiation of a trial often raises more questions than answers. Some of the questions that have been raised are:

- Do the telemedicine technologies and applications improve medical services and/or the health of a community?
- Do telemedicine applications reduce the number of evacuations or lessen the amount of travel required for emergency and/or follow-up care?
- What is the actual value of the reduction in evacuations and travel for emergency and follow-up care?
- What level of documentation is necessary to measure such improvements?
- Are the technologies that are being tested appropriate?
- Has the use of these technologies "transferred" to the user community?
- If the success of an experiment is to be deemed limited or a failure, then, is it a theory failure or an implementation failure? How can we be sure that poor implementation or an external intervening factor did not affect the overall success of an application?
- How did the patients react to the use of these telemedicine applications (e.g. video conferencing)?
- How did the doctor and patient feel about video teleconferencing?
- Do the doctor and patient feel that video teleconferencing improved the level of service?
- How has the provision of information been transferred?

- Do doctors and other medical officers access the available information services?
- Do they feel that the service was valuable?

These are only a few of the questions that have arisen. There is a need to codify and begin to analyze the experiments in relationship to the promises of the technology. However, as stated earlier, it is too soon to undertake such an evaluation since the trials have just begun.

7. SUMMARY

Telemedicine and telehealth applications are important emerging applications for the Pacific Islands Region. Experiments are being proposed and/or conducted in the Pacific Islands Region under many venues, such as PARTNERS, PEACESAT, Tripler Army Medical Center, the Pacific Basin Medical Officers Training Program (PBMOTP), and the Fiji School of Medicine (FIJI-SM). Although it is far too early for an in-depth evaluation of these programs, the efforts so far have been useful in identifying many important issues and questions.

International cooperation and collaboration in the development of telehealth and telemedicine programs in the Pacific Islands Region could expedite experiments exponentially. The basis of cooperation and collaboration among and within the region appear to be developing.

A dialogue on telemedicine and telehealth experiments should be initiated among the service providers, experimenters, end users, and beneficiaries. Such a dialogue could begin to discuss the need to document, evaluate, analyze, and report on the telemedicine technologies, services, applications, methodologies, and evaluation techniques; and will aid greatly in developing an understanding of appropriate applications of these technologies in the Region.

NOTES

1. There are philosophical differences in emphasis in the fields of public health and medicine that are also present in telemedicine and telehealth. These philosophical differences are not discussed here.
2. The official acronym for the Fiji School of Medicine is "FSM." For the purposes of this paper, the acronym "FIJI-SM" is used to minimize confusion with the acronym of the Federated States of Micronesia (FSM).
3. The PEACESAT program is funded, in part, through a Cooperative Agreement between the National Telecommunications and Information Administration (NTIA) of the U.S. Department of Commerce and the University of Hawaii (UH). The program has been in place since 1971, and has been mentioned in the ITU's *Maitland Commission Report* (International Commission, 1984) as critical in facilitating communications during outbreaks of diseases and other medical emergencies. It has also been mentioned in the *U.S. Global Information Infrastructure: An Agenda for Cooperation* for the same reasons.
4. The plan to upgrade the PEACESAT Network is called the PEACESAT Services Improvement Plan and is documented in Okamura and Mukaida (1995 and 1994).
5. This capability could be implemented among the Hub Sites. However, to extend the service beyond the Hub Sites, digital video receive only with voice or data return would have to be developed.

BIBLIOGRAPHY

Hamamoto, N. et al. (1992, January) "Pan-Pacific Regional Telecommunications Network Experiments Using ETS-V," Proceedings of the Pacific Telecommunications Conference '92.

International Commission for Worldwide Telecommunications Development (The Maitland Commission). 1985. The Missing Link. International Telecommunication Union.

Okamura, N. and L. Mukaida (1995, September) "Public service telecommunications: PEACESAT," Pacific Telecommunications Review, 14-23.

Okamura, N. & Mukaida L. (1994) "PEACESAT: A Regional Telecommunications Alliance in Transition," Proceedings of the Pacific Telecommunications Conference '94, 811-819.

PEACESAT Headquarters, Hub Site Request for Proposals, November 14, 1994.

Puskin, D. and Sanders, J. (1995, 19, 2). "Telemedicine Infrastructure Development." Journal of Medical Systems, 1-5 .

Puskin, D. (1995, 19, 1). "Opportunities and Challenges to Telemedicine in Rural America." Journal of Medical Systems, 53-61.

The Global Telecommunications Revolution: Building Both Information Super-Highways and Local Streets

Mr. Ryoichi Sugioka, Executive Vice President
Fujitsu Limited
Tokyo, Japan

A global telecommunications revolution is taking place. The changes involve not only how information is communicated, but also what information is communicated. From Tokyo, Japan to Raleigh, North Carolina, in the United States, the form of these changes is being based on meeting the needs of the people of that region. Fujitsu, as a major participant in the global revolution, has an excellent vantage point from which to view the different ways this revolution is presenting itself to different people.

Good morning, ladies and gentlemen. Before I begin, I want to thank the organizers of PTC '96 for bringing all of us together in this forum. It is a great honor for me to address so august a group representing the world's telecommunications industry.

Indeed, this meeting is something of a modern miracle. Not so many years ago it would have been impossible. The barriers of time and distance would have been too great to permit our meeting conveniently. Today, however...thanks to jet transport...we are only hours from one another no matter where we live.

We are the beneficiaries of a revolution in the technology of transportation which has occurred very quickly and has radically changed the way we perceive ourselves and the world. In fact, the change has happened so fast and its effects have been so far-reaching that we sometimes take it for granted. Rather than being awed at our ability to move at will from continent to continent, we instead are frustrated that the scheduling of flights is not more convenient. We forget that we are now moving more people to more places more quickly than ever before.

We here in this room are also revolutionizing transportation...the transportation not of people but rather of information. This is a revolution of which we are all deeply conscious because we are in the midst of it, helping to shape it and even directing its course. Like the revolution in physical transportation, this one will also change the way in which the peoples of the world live, the way they perceive themselves and others.

This revolution is being driven by the need of people everywhere in the world to communicate more widely, more fully and more quickly. It is being driven not only by the commercial needs of the business community but more and more by the social needs of private citizens. One can see this driving force everywhere...in the growth of cellular telephones, in the increasing number of personal computers, in the use of the Internet and e-mail. To satisfy this need, we are busily building more and more complicated networks linking enterprises, communities, nations and continents with the goal of creating first National Information Infrastructures and finally a Global Information Infrastructure which will make communication with all parts of the world instantaneous.

Naturally, the revolution in telecommunications is proceeding at a different pace in different places. In some areas of the world the information highway is still unpaved while in others it is a modern, multi-lane thoroughfare. Because the switches we make at Fujitsu serve the needs of all networks from the most elemental to the most advanced and because we deploy them all over the world, we are in a position to observe and report on the global state of the telecommunications revolution. I would like to share some of our observations with you.

Of course, the telecommunications revolution is most advanced in the most highly industrialized countries where it is being driven hard by demands for both commercial and home applications. In the United States, Fujitsu participated with the State of North Carolina and several public networks serving that State in the creation of the world's first statewide, broadband network...the North Carolina Information Highway. Based on ATM and SONET technologies, this highway has been delivering educational, healthcare, administrative and commercial services to the people of North Carolina for the past year.

Via the highway, thousands of students in almost 100 public schools across the state attend classes on subjects to which they would otherwise not have access. Sitting in classrooms...some of which are hundreds of miles from one another...students interact with one another and the teacher as though they were all in the same room.

At the same time, doctors in metropolitan medical centers hold video consultations with patients in rural areas. This practice not only raises the level of healthcare in rural communities but also saves rural patients the cost and inconvenience of travelling to urban medical facilities for advanced medical services.

Other services...the training of civil service workers, the judicial arraignment of prisoners, meetings between state employees at remote locations...are also provided on a day by day basis over the highway.

The business arrangements which built the North Carolina Information Highway were as radically advanced as the technology used to support it and provide a paradigm for the way such enterprises will be conducted elsewhere.

The NCIH is the result of a risk-sharing partnership between service providers, their equipment vendors and government. Each of the participants shared in the benefits as well as the costs and risks of developing the infrastructure.

The equipment providers benefited from early trial experience and an assured introductory market for developing products using the latest technology.

Service providers benefited from a committed, revenue-paying anchor customer for new, advanced network capabilities.

And the people of North Carolina benefited from improved educational, healthcare and state-provided services.

Similar highways are being planned and implemented in the Far East. In Japan, the Ministry of Posts and Telecommunications plans to build one by the year 2010 and its experiments in broadband networking and various ways of enhancing networks are either underway or planned at "keihanna" in the western part of Japan. NTT also has announced plans for a broadband network, and...as part of its "NTT's Basic Concept Toward the MultiMedia Era"...is gaining know-how through both its internal experiments and a multimedia communications experiment with end users.

In collaboration with NTT, the newspaper Nihon Keizai Shimbun and its publishing division Nikei BP as well as NHK Information Network, Inc., a subsidiary of the national broadcasting station and JTB Information Development, Inc., a subsidiary of Japan Travel Bureau, Fujitsu is conducting a trial of a MEDIA TOWER, a video information retrieval system. And in cooperation with CATV companies such as Yokohama TV and City TV Nakano, we are conducting trials of TV-based services such as Video on Demand, PC-based on-line shopping and distance learning.

Elsewhere, South Korea is enthusiastically pursuing its KII plan, while Singapore's IT 2000 plan calls for renovating its network and Hong Kong is preparing similar action.

In developing nations, of course, the revolution in telecommunications is at a much different stage. Here the task is to provide not multimedia but rather widely available telephone service. This will not be a simple job because these nations hold the vast majority of the world's population. However, the governments of most of these nations realize the close relationship between the number of telephones per capita and the pace of economic development, and have made providing telephone service a top priority. Further, these governments realize that the establishment of a network gives them the opportunity to leap frog into the age of cyberspace. The impact of distance learning and telemedicine on the economies and healthcare delivery systems in these nations could prove to be immeasurable.

There is no question that the goal of the telecommunications revolution...universal connectivity...is within sight, but it is not yet within reach. We have many obstacles to surmount before we reach our objective. These obstacles are economic, technical and social.

Basically, with ATM and SONET technology we theoretically have the technical ability to "plug in the world." A transmission system with a capacity of 10 Gbps is already commercially available. Super high speed transmission rates beyond even this level are projected through the use of wavelength division multiplexing and optical amplifying. And an ATM switch that can handle 160 Gbps stands ready to handle this massive flow of information.

Of course, speeding up the local distribution network, the so-called "fiber to the home," will also be a key factor. Unfortunately, the cost of providing fiber to this crucial last one mile is still expensive. Technical solutions may involve alternatives such as hybrid fiber optics and coaxial cable or wireless Multichannel Multipoint Distribution Service.

And the search is still on for the "killer" application which will drive the demand for broadband service. But I believe we may have found this application in the Internet. As you know, use of the Internet is growing in almost quantum leaps and those who have used the Internet have experienced frustration at its slow response time and lack of full motion picture capability. Both of these problems should build a growing appetite for more bandwidth in the network.

Whatever the future holds, few can doubt that it will feature some form of an Information Super Highway, a network of networks. What form the GII takes and when it takes form will depend not on any one of us but rather upon us all. For the telecommunications revolution is by nature democratic, a great cooperative enterprise which will be defined by the voices and contributions of many. For the Super Highway will not tolerate proprietary technologies and closed systems. If it is to work at all, it must be interoperable and such interoperability requires great cooperation among vendors and network providers, among the providers themselves, among providers and governments, and among the governments of different nations.

Thus the very process of creating the GII will further the major goal of the GII...greater international communication, cooperation and understanding. The complex technology with which we occupy our daily lives is only a means to this goal...a goal which I think we can all agree is worthy of our life's efforts.

Network Construction Plan for NII in R.O.C.

Steven Y. Chen and Duei Tsai

Directorate General of Telecommunications, M. O. T. C.

Taiwan, R.O.C.

Abstract

In order to effectively set up NII in R.O.C., a "NII Promotion Task Force" is established to conduct all NII activities by the Executive Yuan. Telecommunication plays an important role for NII. Under the "NII Promotion Task Force", we have a "Network Construction Team", directed by the Ministry of Transportation and Communications (MOTC) and handled by the Directorate General of Telecommunications, to build a NII communication backbone. Meanwhile we also identified some action items for NII, such as managing and planning radio spectrum, revising the telecommunication regulation, studying 2-ways communication law for CATV, . etc.

In this paper, we propose network construction and network operation strategies to meet NII various requirements. Based on these strategies, we set up the construction plans in activating ISDN service, deploying the HiNet network, building the broadband trial network and establishing video-on-demand testbed. All network constructions are served as the network backbone for NII applications.

In NII superhighway, we propose a broadband trial network. In order to support this trial, Telecommunication Laboratories (TL) of DGT has already accomplished the development of ATM virtual path switch, SDH/SONET add-drop multiplexer (ADM600/ADM150), optical amplifier and modules, and some NII application services.

Due to the challenge of NII, the overall telecommunication services are changing fast in Taiwan. To satisfy the customer needs, the related telecommunication deregulation actions have been proposed and will be realized in the near future. Among these plans, the reorganization of DGT and telecommunication liberalization are two key tasks of telecommunication evolution plan. The goal of these tasks is to offer the open competitiveness and to improve the service quality for all NII users.

1. Introduction

1.1 Motivation

The revolution in telecommunications industries has profoundly changed in every country around the world. Since US set forth NII in February 1993, National Information Infrastructure (NII) has gradually become a popular and commercial reality in telecommunication and information service. It has a significant effect on the business of telecommunication industry for sometime to come, and its impacts are larger than the total value spent in moving ahead toward NII. In the national point of view, NII reveals a new driving force to encourage private investment, promote the gross national product growth , improve living quality, provide easy access to government services through new communication media and applications. To meet NII development trend, the following two major tasks are set:

. to evolve telecommunication network into broadband network.

. to reform telecommunication laws, regulations and processes in rebuilding NII information backbone.

Due to the challenge of NII and the industrial development, the government of the Republic of China has also decided in 1994 to develop a policy for establishing a national project to promote NII through integrating national resources. We have made some progresses and achievements in the broadband network construction and information applications.

1.2 NII Task Force

In order to realize the NII proposals, a NII task force [1] was established in August 1994 by government agencies and several private sectors. It is under the jurisdiction of the Executive Yuan and headed by Dr. H. M. Hsia (Ministry Without Portfolio). According to the responsibility of each ministry, the task force is partitioned into five various subfunctions and chaired by the Vice-Minister of the relevant ministries:

(1) resource planning, chaired by the Council for Economic Development and Planning

(2) network construction, chaired by Ministry of Transportation and Communications

(3) applied technologies and deployment, chaired by Ministry of Economic Affairs

(4) human resource education and basic application, chaired by Ministry of Education

721

(5) general affairs and consultation, chaired by Executive Chief of Institute for Information Industry.

In addition, one civil advisory council acts as consultant in the requirements of private sectors and one secretary offers the administration aids to this task force.

2. NII and Telecommunication Network

2.1 Goals of NII Telecommunication Network

As a network provider endowed with the mission to realize the NII project, DGT's major goals are listed as follows :

(1) promote the telecommunication service quality
DGT will provide diversified, high quality, economical, convenient and highly efficient telecommunication services to satisfy customer needs in all NII applications. The quality of network services must be of high grade so as to strengthen national competitiveness.

(2) establish the NII network
A high speed, broad-band telecommunication network is necessary for the video, data, and voice communication of NII applications.

(3) support the required telecommunication services in the Asia-Pacific Regional Operations Center
Telecommunication network should provide diversified telecommunication services that is the foundation for R.O.C. to become an Asia-Pacific regional operation center.

(4) manage and allocate the radio frequency spectrum
The management and allocation of radio frequency needs some efforts and improvements in information broadcasting and exchange through wireless communication.

(5) interconnect the existing network and future network
Directorate General of Telecommunications (DGT) must offer the network-network interconnectivity which is a key attribute in NII networks.

(6) publicize the equipment procurement plan and telecommunication liberalization schedule.
The publication of procurement plan can help the private sectors understand how to contribute their resource to NII plan and construction. Hence the overall national productivity can be improved quickly and economic growth can be accomplished easily.

(7) research the NII related technologies and transfer the technologies to private sectors
The research and development of NII technology covers various new topics in transport network, switching, customer access, and operations support that are major research issues in Telecommunication Laboratories of DGT.

2.2 Network Construction Plan

The construction of telecommunication network is a service and operation topic that covers network forecasting, network planning, network operation, network administration, network maintenance ,and network provision, etc. These topics shows that a suitable and cost-effective methodology is a good approach in NII network construction. After several discussions and studies of many telecommunication expertise, we propose our construction plan in 4 different domains.

(1) Network Modernization

Item	Description
Optical fiber network	1. Construction of 46,226 core Km of optical fiber subscriber loop 2. Construction of 460,000 core Km of long distance network
Digitize exchange facility	Installation of 3.2 million lines of local digital exchanges
Intelligent network	Construction of the intelligent network with domestic and International Advanced Free Phone services (AFP, IAFP), domestic and International Credit Telephone Service (CTS, ICTS), domestic and International Virtual Private Network (VPN, IVPN), and Mass Calling Service (MCS)
Mobile Communication	1. Construction of the 4th system for radio paging 2 Construction of GSM mobile phone network 3. Construction of trunked radio system 4. Setting up low tier personal communication system for field trial

(2) ISDN network

Through many efforts of DGT and ISDN vendors, ISDN service has been opened to serve several metropolitan cities since June 1995. The following is our detailed plan for NII.

a. the 1st phase construction of ISDN
We have completed 3072 ISDN ports over 4 major areas and the detailed construction is as follows :

Taipei	1536 ports
Taichung	512 ports

Tainan	512 ports
Kaohsiung	512 ports

b. the 2nd phase ISDN construction will be completed before June 1997 and a total of 15,500 ports will be constructed.

(3) Broadband Telecommunication Network

A broadband network is generally the basis of information highway and requires more resource investment. Nevertheless, it can also promote economic growth, but the key issue is how to plan, establish, deploy , operate and maintain a reliable network for all users. Our approach is described as follows:

a. Planning Principle
  . Satisfying all leading systems, high speed network systems
  . provide safe, reliable and bi-directional broadband telecommunication networks
  . provide services with locally developed ADM and ATM products and speed up the technological foundation of local maker
b. Broadband Field Trial Networks
  . Taipei area includes Chengchung and Hsinyi district of Taipei city
  . Hsinchu area covers metropolitan Hsinchu and Hsinchu Science-Based Industry Park
  . Taichung and Kaohsiung area
c. Network Facility Functions
  . Point-to-point and multicasting communication
  . Direct control of network/scheduler
  . Fast reconfiguration
  . Switched DS1/DS3; DS1/DS3 service and semipermanent links
  . DS1/DS3 multiplexer

(4) Expand the Data Marketplace

The data service is clearly a key information service of NII, but data traffic is still too little in Taiwan telecommunication services. Promoting the data services becomes a crucial communication policy and action plan. Therefore the goal of data service is to create traffic which will account for more than 7% of telecommunication revenue, and the plans are listed as follows:

a. DGT will provide a Taiwan NII network for building government administrative information systems to facilitate convenient and easy inquiry of government information.
b. Meanwhile DGT will establish a high speed data network including the following networks :
  . a nation-wide Frame Relay network
  . an ISDN network for primary rate
  . expansion of the packet switching data network
  . a HiNet service based on Frame Relay (in order to provide the whole island with Internet service)

3. NII Trial network in Taiwan

3.1 Network Services in NII

According to the service requirement of high speed communication, the new network services are classified as follows:

(1) Permanent connection services
  transmission rate is 1.544 Mbps or 44.736 Mbps
(2) Public data switching network services
  provide services under 1.544 Mbps through X.25, Frame Relay
(3) Semi-permanent connection services
  transmission rate is 1.544 Mbps or 44.736 Mbps
(4) Broadcast type one-way telecommunication service
  transmission rate is 1.544 Mbps or 44.736 Mbps
(5) Multi-point video conference service
  transmission rate is 1.544 Mbps or 44.736 Mbps

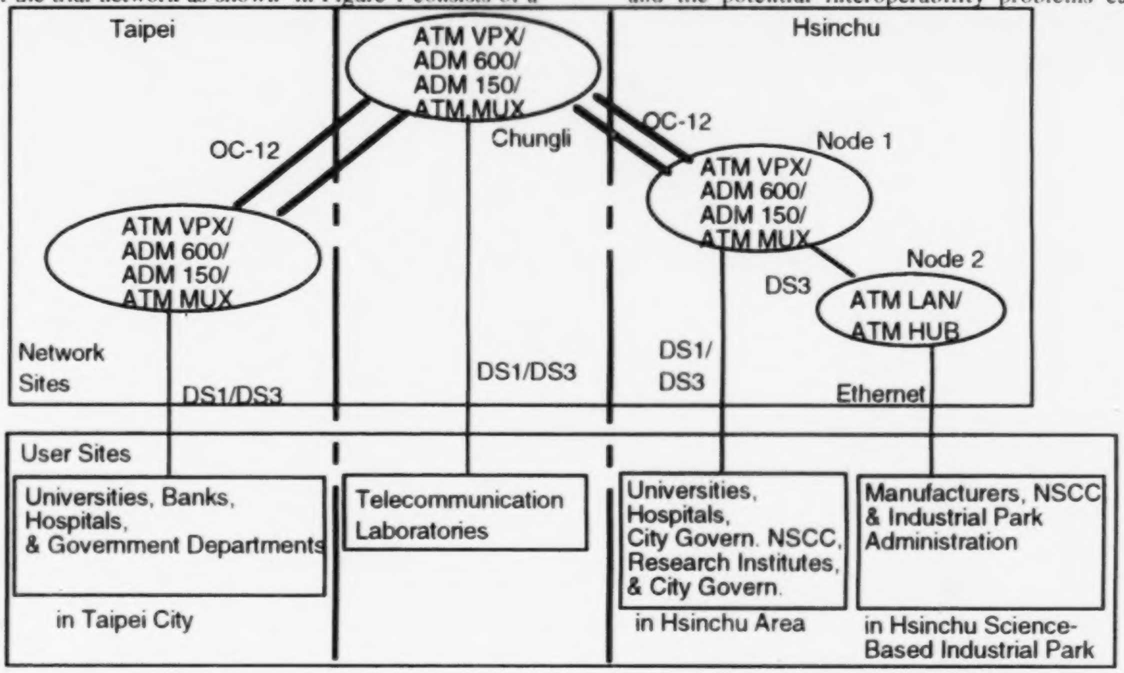
Exploiting the above services, we have accomplished the following NII applications through the broadband field trial network:

. Home shopping
. Telemedicine
. Multi-media database service
. Video on demand
. Remote library service
. Video conference
. Auto customs brooking
. Distance learning
. Weather broadcast
. Tele-commuting

3.2 Network Architecture

The trial plan directly offers a broadband SDH/ATM network supporting all NII needs. Both ATM and ADM technologies are simultaneously planned and exploited among the trial network which intends to give a NII paradigm. In normal case, a ATM switch with 155 Mbps (OC-3c) trunk facility is a key medium which serves all NII user sites operating DS1/DS3 rate. In the same time, a SDH network implemented by using ADM 600/150 can drop OC-12 trunk lines to OC-3, DS1, and DS3 rate. Therefore SDH network based on ADM 600/150 can independently provide DS1/DS3 services without ATM switch support. Such a network platform can assure the reliability and redundancy for user services.

According to the above architecture, an experimental broadband SDH/ATM network and its relevant pilot applications are built, tested and verified for the feasibility of tele-medicine, distance-learning, teleconference, and electronic commerce, etc. Each node of the trial network as shown in Figure 1 consists of a ATM virtual path switches (VPX), ATM multiplexer, and SDH add-drop multiplexers (ADM 600/150). The same ATM switches are used among this trial network, and the potential interoperability problems can be


Taipei
ATM VPX/ ADM 600/ ADM 150/ ATM MUX
Chungli
Hsinchu
OC-12
OC-12
Node 1
ATM VPX/ ADM 600/ ADM 150/ ATM MUX
ATM VPX/ ADM 600/ ADM 150/ ATM MUX
Node 2
DS3
ATM LAN/ ATM HUB
Network Sites
DS1/DS3
DS1/DS3
DS1/ DS3
Ethernet
User Sites
Universities, Banks, Hospitals, & Government Departments
in Taipei City
Telecommunication Laboratories
Universities, Hospitals, City Govern. NSCC, Research Institutes, & City Govern.
in Hsinchu Area
Manufacturers, NSCC & Industrial Park Administration
in Hsinchu Science-Based Industrial Park

NSCC : National Super Computer Center

Figure 1 A Broadband Trial Network Of NII

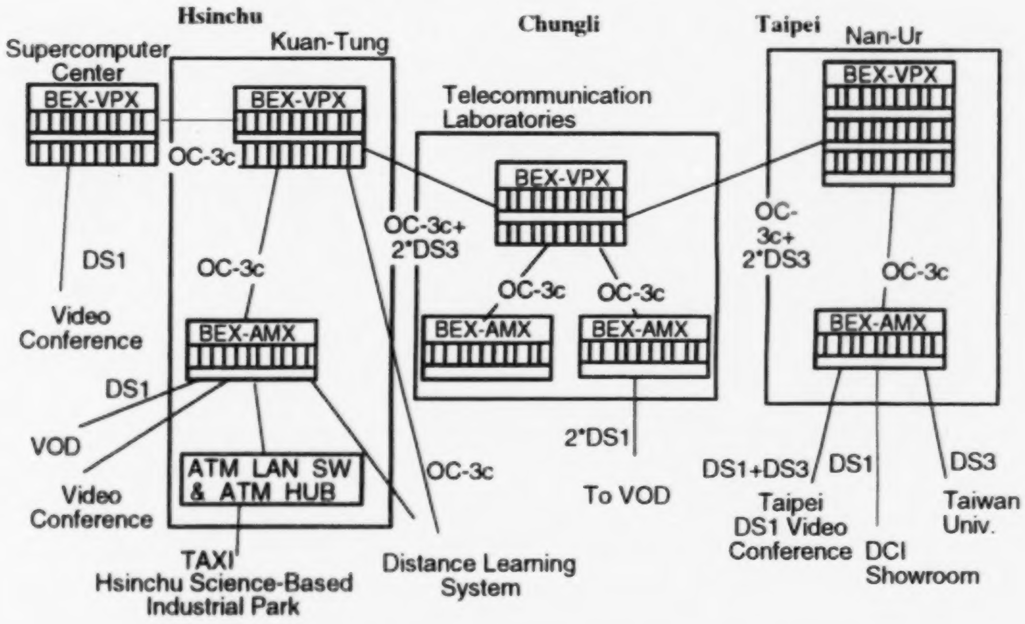

Hsinchu
Supercomputer Center
Kuan-Tung
BEX-VPX
BEX-VPX
OC-3c
DS1
Video Conference
OC-3c
BEX-AMX
DS1
VOD
Video Conference
ATM LAN SW & ATM HUB
TAXI
Hsinchu Science-Based Industrial Park
OC-3c+ 2*DS3
OC-3c
Distance Learning System
Chungli
Telecommunication Laboratories
BEX-VPX
OC-3c
OC-3c
BEX-AMX
BEX-AMX
2*DS1
To VOD
Taipei
Nan-Ur
BEX-VPX
OC-3c+ 2*DS3
OC-3c
BEX-AMX
DS1+DS3
DS1
DS3
Taipei DS1 Video Conference
DCI Showroom
Taiwan Univ.

Figure 2 A Broadband Network based on ATM Switch for NII Trial

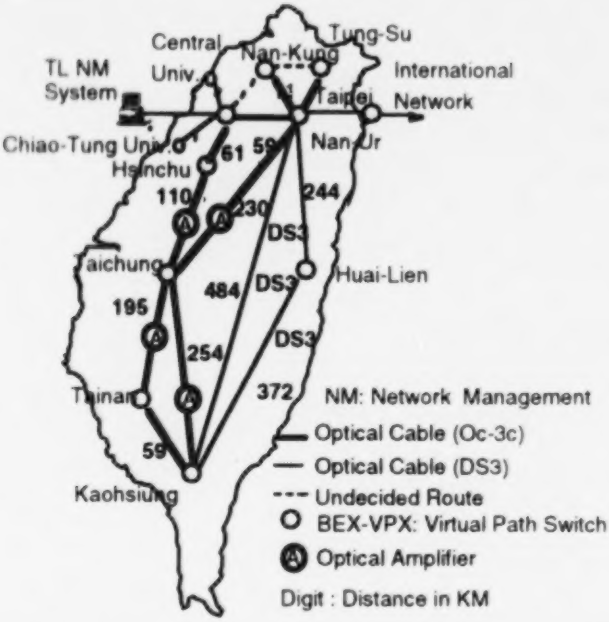

Central Univ.
Nan-Kung
Tung-Su
International Network
TL NM System
Taipei
Chiao-Tung Univ.
Hsinchu
61
59
Nan-Ur
110
230
244
DS3
Taichung
484
DS3
Huai-Lien
195
254
DS3
Tainan
372
59
Kaohsiung
NM: Network Management
Optical Cable (Oc-3c)
Optical Cable (DS3)
Undecided Route
BEX-VPX: Virtual Path Switch
Optical Amplifier
Digit : Distance in KM

Figure 3 A Broadband Service Trial Network Based on ATM VPX

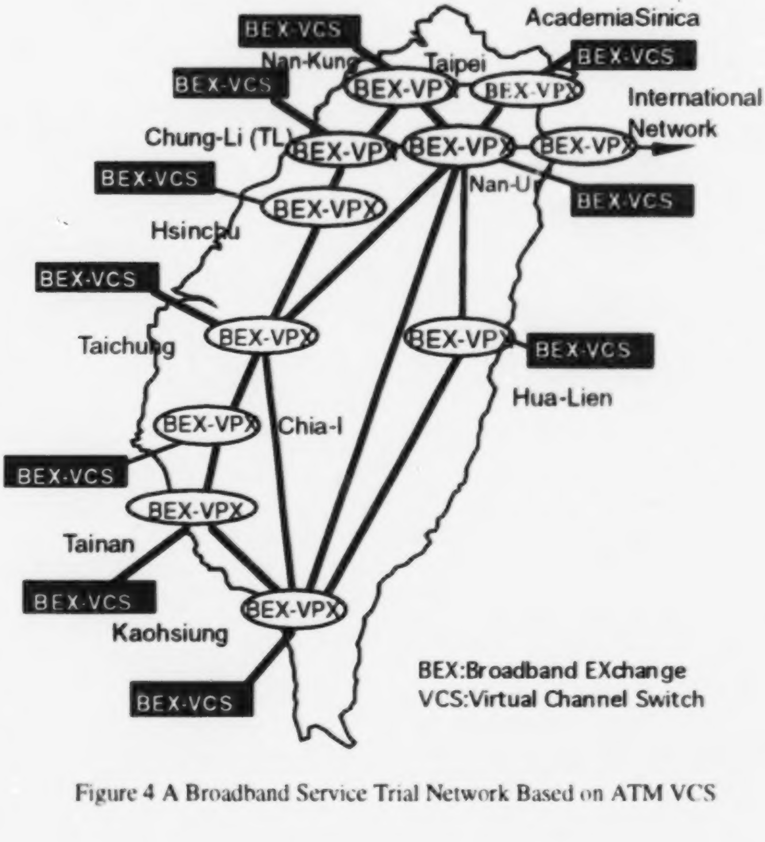

BEX-VCS
AcademiaSinica
Nan-Kung
Taipei
BEX-VCS
BEX-VCS
BEX-VPX
BEX-VPX
International Network
Chung-Li (TL)
BEX-VPX
BEX-VPX
BEX-VPX
BEX-VCS
Nan-Ur
BEX-VPX
BEX-VCS
Hsinchu
BEX-VCS
BEX-VPX
BEX-VPX
BEX-VCS
Taichung
Hua-Lien
BEX-VPX
Chia-I
BEX-VCS
BEX-VPX
Tainan
BEX-VCS
BEX-VPX
Kaohsiung
BEX-VCS
BEX:Broadband EXchange
VCS:Virtual Channel Switch

Figure 4 A Broadband Service Trial Network Based on ATM VCS

avoided. Under this architecture, the network trunk interfaces between each node are OC-12 for ADM 600 and OC-3c for ATM VPX, and DS1/DS3 is major interface between network node and user site.

Although the NII trial plan exploits SDH/ATM technologies, the envisioned NII network indicates a strong preference for an ATM-based solution. The SDH network based on ADM technology merely plays a backup function in network communication. While network technologies are gradually evolving, the SDH network will eventually be a transport network between ATM switch nodes. Figure 2 illustrates a broadband network based on ATM VPX for NII trial.

3.3 Broadband Service Trial Network

A fully deployed nation-wide broadband service network is expected to be accomplished in July 1997. There are in total seven domestic ATM VPX switch nodes and one international ATM VPX switch. Meanwhile an optical amplifier (OA) is used for long distance fiber trunk lines without repeaters. After accomplishing the development of ATM Virtual Channel Switch (VCS), we will update our broadband service trial network in ATM VCS switches and provide switched virtual circuit (SVC) services. The trial time table of ATM VCS switch will begin in August 1997 and end in July 1999. Figure 3 and 4 show a broadband service trial network based on ATM VPX and VCS respectively.

4. The Improvement of Telecommunication Environment

Due to the challenge of NII, the overall telecommunication services are changing fast in Taiwan. For satisfying the customer needs, the related telecommunication deregulation actions have been proposed and will be realized in the near future. Among these plans, the reorganization of DGT and telecommunication liberalization are two key tasks in the telecommunication evolution plan. The goal of these tasks is to offer open competition and to improve the service quality for all NII users.

4.1 Reorganization Plan of DGT

In order to meet the future telecommunication needs and enhance competitiveness, Directorate General of Telecommunications (DGT) is moving toward corporatization and eventually privatization. According to the restructure proposal, DGT will be partitioned into two separate entities in the near future. One function is regulatory role and another is business operation. The former will be performed by DGT and the latter will be managed and operated by Chinese Telecommunications Corporation which is a state-owned telecom operating company. Through a series of public hearings of telecommunication, we have accomplished the related reorganization proposals. Currently the draft proposal of the "Telecom Act", the "Statue for Chinese Telecommunications Corporation", and " DGT Organization Statue" have been submitted to the Legislative Yuan for approval.

4.2 Telecommunication Liberalization Plan

Table 1 The status of liberalized telecom services

year	services to be liberalized
1987	self-equip local telephone equipment
July 1989	Value-added network services: information storage and retrieval information processing remote transaction, word processing editing voice mail, electronic mail bulletin board service electronic data interchange (EDI)
July 1990	self-equip in-house subscriber lines
Aug. 1994	cordless telephone service within building (CT2-PBX)
Nov. 1994	CT-2 public service
Dec. 1994	Packet switching, store-and-forward fax service

Under the impact of keen competition on the global market, most telecommunication operators over the world are changing their monopoly status. In Taiwan, we have liberalized some services since 1987. Table 1 shows the relevant services to be liberalized.

Realizing NII plan and the goal of developing Taiwan as an Asia-Pacific operation center, it is necessary to provide better telecommunication services for satisfying the needs of all domestic and international companies. Therefore the services in Table 2 will be liberalized and opened for competition in the near future.

Table 2 The future liberalized telecom services

year	services to be liberalized
Dec. 1995	mobile data, trunked radio, VSAT
under planning	cellular mobile phone, radio paging

To cope with competitive and changeable telecom environment, DGT has been taking some concrete measures to enhance its competitiveness. Several measures are listed as follows:

. The tariff structure has periodically been reviewed to become more competitive.

. The network construction is well undertaken to become more digital, optical and intelligent.

. The personnel exchange programs are reinforced.

. The relationship with foreign companies is further strengthened to promote international cooperation.

5. Conclusion

NII is a long time endeavor. It evolves in tandem with technological advancement, and it has a great impact to national development in a broad scale. The success of NII depends on not only sufficient resource and capital investment, bust also a strong technology foundation and its application capability. The priority must be focused upon professional development and promoting information technology application to the industry in each field.

For the creation of a healthy development environment in all respects, there is the need to further encourage private participation and investment. The government has also an undeniable role in technology R&D to accelerate information development for supporting economic growth and social evolution. We must seize the opportunity to enhance our relative advantage in the fiercely competitive global market, and to advance ROC among one of the developed "Information Society" nations in the early 21th Century.

References

[1] The Executive Yuan of R.O.C. , "The 5th SRB Meeting on Electronics, Information & Telecommunication, Background Reports," July 1995.

[2] S. Patterson and W. L. Smith, "The North Carolina Information Highway", IEEE Network, Nov. 1994, pp. 12-17.

[3] R . Capell et. al., "Evolution of the North Carolina Information Highway", Nov. 1994, pp. pp. 64- 70.

[4] J. Motiwalla et. al., "Building the Intelligent Island," IEEE Communication Magazine, Oct. 1993, pp. 28-34.

Future Directions for Telecommunications in Thailand

Philip Parker[1], Arthur Owen[2] and Andrew Myles[3]
Arthur D Little
Sydney, Australia

1. Abstract

In the past, the telecommunications industry structure in Thailand has been driven by a restrictive regulatory regime and political expediencies. This structure is clearly untenable in the future because it discourages competition on the basis of both service innovation and price, it leads to conflicts of interest for the regulators and it extracts unfair economic rents from the private sector. However, there is broad consensus concerning the need for reform and some even aspects of the reform, such as the need for an independent regulator, the privatisation of existing government operators and the licensing of new service providers. Although a recent change of government has delayed the reform process, there is a general confidence that it will ultimately occur and that the resulting structure will include the public and private sector in a modern telecommunications industry that provides a range of integrated service offerings comparable to the rest of the world.

2. Present Telecommunications Industry Structure Driven by Restrictive Regulation and Political Expediency

Any person who has tried to travel from one side of Bangkok to the other through the hopelessly congested traffic can easily appreciate that investment in transportation infrastructure in Thailand has not kept pace with the economic growth that puts hundreds of new cars on the streets of Bangkok every day. Likewise, any person who has tried to make a telephone call from a public telephone in Thailand would realise that the development of the telecommunications infrastructure has also lagged the demands of a fast developing economy. Development of the Thai telecommunications industry has been greatly constrained by outmoded laws that vest all operational responsibility for telecommunications services with the government sector, demanding convoluted contractual arrangements to engage private sector capital and operating efficiencies in the industry.

2.1. Law Gives Monopoly Operating Right to Government Entities

In Thailand, the law gives the government the exclusive right to operate telecommunications services. In practice this occurs through two entities; the Telephone Organisation of Thailand (TOT) has the monopoly right to offer domestic telecommunications services and the Communications Authority of Thailand (CAT) the right to offer international telecommunications services as well as postal and telegraph services.

In the 1970's and 1980's, TOT began to involve the private sector in non-PSTN telecommunications services through Build-Transfer-Operate (BTO) contractual arrangements. These required the concessionaire to build the necessary infrastructure, transfer ownership to TOT, and then operate the service for a defined concession period. The initial service offered in this way was a paging service, which involved Pacific Telesis. Further paging concessions followed, then concessions for cellular telephone service, fibre optic long distance transmission service along the rights of way of the State Railways of Thailand, a submarine fibre optic cable across the Gulf of Thailand, mobile trunked radio, and pre-paid card telephones.

Over the same period, CAT issued concessions for cellular telephone service, paging and PCS. In doing so, they broke the traditional division between international and domestic telecommunications services. Finally, the Ministry of Transport and Communications issued a concession for a domestic satellite service.

2.2. Telephone Organisation of Thailand was Unable to Meet Growing Demand for Service

All concessions issued up until the end of the 1980's had been for non-PSTN services. However, the 1980's had been a decade of exceptional economic growth for Thailand and this caused a very rapid growth in demand for PSTN services. In fact, despite TOT increasing the size of its network significantly, its waiting list for telephone service kept growing, and it was not unusual for applicants to have to wait several years before receiving telephone service.

The main reasons for TOT's inability to keep pace with demand were:

- Equity injections into TOT were limited by the government's desire to maintain low budget deficits, as part of its commitment to responsible macro economic management
- TOT's debt to equity ratio was high, limiting its ability to raise further debt
- TOT's operating efficiencies were low using most standard measures, such as number of lines per staff member, faults reported per line per month and number of completed calls. This meant that TOT had a high cost structure, resulting in low income and hence an inability to fund network expansion from retained earnings
- TOT had difficulty dealing with the logistics of expanding its network further.

2.3. PSTN Concessions Awarded to the Private Sector on Build Transfer Operate Basis

As a result of the desperate shortage of telephone lines, the government decided to award BTO concessions to the private sector for the expansion of the PSTN. The first concession awarded, for 3 million lines nationwide, to CP Telecom, was withdrawn after a change of government, with the allegation that the concession was too generous to the concessionaire. The project was then split into two. In Bangkok, a two million line concession was awarded to CP Telecom, which later was renamed TelecomAsia. In the provincial areas, a concession for one million lines was awarded to Thai Telephone and Telecommunications (TT&T), a consortium of the Loxley Group, the Jasmine Group and NTT.

The two concessions differ in their financial terms. From TelecomAsia, TOT receives 16 percent of revenues and a share of profits over 16 percent return on equity. From TT&T, TOT receives a higher share of revenues, 44 percent. The difference in revenue sharing terms partly reflects the different revenue per line generated by each concession. TT&T will receive greater revenue per line than TelecomAsia because subscribers in up-country areas, which TT&T covers, will tend to make a greater number of more expensive long distance calls.

The two concessions are similar in most other respects. Both are for installation and operation of a local exchange network only. The long distance transmission network is a combination of TOT's own network and transmission capacity installed under other concessions. Both TelecomAsia and TT&T have the responsibility for building the network and as it is completed in stages, transferring ownership to TOT. For those parts of the network transferred, TOT then assigns lines to customers through its commercial offices. The concessionaire performs the necessary network functions for connecting the customer, such as connecting the drop wire to the customer's home and making the data changes in the exchange and billing data bases to allow the customer to receive a chargeable dial tone. The concessionaire issues bills, but TOT is responsible for collecting revenues from the customer.

2.4. Regulation of Broadcasting Industry is Completely Separate to Telecommunications

Given that the telecommunications and broadcasting industries are converging around the world, it is of more than academic interest to examine the potential for convergence within the regulatory structure in Thailand. For example, in the USA, the existence of a common regulatory authority for both the telecommunications and broadcasting industries is facilitating the entry of cable TV companies into telecommunications and vice versa. In Thailand, the regulation of the two industries is entirely separate. In fact, there is no single regulator of the broadcasting industry in Thailand, with responsibility being split among several authorities.

The National Broadcasting Committee, a ministerial level committee sets overall policy for the sector. The Post and Telecommunications Department administers the allocation of radio spectrum. The Public Relations Department acts as a secretariat to the National Broadcasting Committee and also operates one free to air television station. The Mass Communications Organisation of Thailand (MCOT), a statutory authority, operates one free to air television station under its own auspices and a second channel under a concession agreement with Bangkok Entertainment Company. The armed forces operates one television station directly and another through a concession arrangement with the private sector.

In recent years, MCOT has been profligate in issuing concessions to the private sector for subscription television. Its first concessions were to IBC (a Shinawatra Group company) and to Thai Sky. Both these companies introduced microwave multi-point distribution service (MMDS) with five channels each. Despite a lack of local programming, IBC has been relatively successful, gaining about 150,000 subscribers. Thai Sky, on the other hand, has only about 35,000 subscribers, which is attributed to its frequent changes of ownership and hence inconsistent management direction, an unappealing programming mix, and generally poor signal quality. Both companies plan to migrate their service in 1995 to Direct Broadcast Satellite (DBS). This will offer improved coverage and signal quality, as well as the ability to encrypt signals to stem unauthorised signal reception.

More recently, MCOT has awarded subscription television concessions to UTV, a TelecomAsia company, to Bangkok Entertainment Company, operator of one of the free to air channels, and to UCOM, a large telecommunications group in Thailand. Each of these has plans to operate a cable television network. UTV has already begun to roll out its network, and plans to use, as far as possible, spare fibre optic transmission capacity in the TelecomAsia network for its feeder network. Bangkok Entertainment Company is also intending to roll out a hybrid fibre coaxial network, and since both concessions are for nationwide operation, it is likely that there will be areas where the two networks overlap. The plans of UCOM are not yet clear and rumours suggest that they now regard the subscription television sector as too crowded and are unlikely to proceed.

One of the key government policies for the sector is that there should be a clear separation between free to air television and subscription television. The government is concerned that free to air television continues to be available to those people in Thailand who are unable to afford subscription television. One way it does this is to ensure that subscription television does not carry advertisements, which could divert advertising revenue from free to air television with a resultant lessening of the program quality.

However, this policy has some unfortunate consequences. Because subscription television can carry no advertisements, it cannot easily retransmit the free to air channels because they contain advertisements. It also cannot easily retransmit the advertisements contained in the international television channels received by satellite. For example, when CNN is viewed in Thailand, it contains blank periods where the advertisements have been removed.

3. Industry Structure is Untenable in the Future

The process of awarding private sector concessions has been successful in its limited aim of achieving fast infrastructure build out to meet the demands of a rapidly developing economy. However, it has also led to many problems that make the practice untenable for the future.

3.1. Exclusivity Causes High Tariffs

Until now, concessions for the fixed line network have been on an exclusive basis. This has meant that there has been no competitive pressure on tariffs. In addition, the concessions mandate that the tariffs must be the same as for the TOT service. Call tariffs in Thailand for both international and long distance service are high by international standards. For example, the maximum long distance tariff for a domestic call in Thailand is 18 Baht per minute, or approximately US$0.72 per minute. In the United States, a similar call may cost a quarter of this amount. For international calls, an IDD call from Thailand to the USA costs 60 Baht per minute, or approximately US$2.40 per minute. A similar call in the reverse direction would cost less that US$1.00 per minute.

For cellular telephone service, the existence of an uncompetitive duopoly has also resulted in high prices. In addition to the high call charges dictated by TOT, the cellular operators have charged a premium of several hundred dollars on each handset as a way of offsetting the investments in their networks.

As business in Thailand becomes increasingly internationalised, high telecommunications costs will become a significant burden on industries attempting to become internationally competitive. It will therefore become important for the government to introduce a regulatory regime in which real competition imposes downward pressure on prices.

3.2. Tight Definitions of Allowed Services in Concessions Stifle Innovation

Each of the private sector concessions in the telecommunications industry in Thailand has a tight definition of the services it is allowed to offer. This means that there is little possibility of service innovation and integration of different services into a complete service offering.

For example, TelecomAsia has been in discussion with TOT for over two years over the right to install pay phones on the fixed line network that it is installing in

Bangkok. Under the terms of TelecomAsia's two million line telephone network concession, the company must apply separately to TOT to offer services not explicitly mentioned in the concession. However, it would clearly have been in both the public interest and TelecomAsia's interest to install pay phones. It would have been in the public interest because there are few pay phones in Thailand (only 0.5 per 1,000 people compared to 10 per 1,000 people in Singapore) and many of those that exist are outdated and dilapidated. It would have been in TelecomAsia's interest to install pay phones because pay phones typically attract high revenues in Thailand.

Similarly, some of the more innovative services becoming available in developed countries, such as a single bill for all services, calling card, call forwarding from fixed to mobile line and vice versa, and voice mail linked to no answer at a telephone number will not become available in Thailand until the advent of regulatory reform.

3.3. Conflict of Interest Exists Between TOT and Concessionaires

The concessions are called "Joint Investment and Operating Agreements" between the concession granting body, and the private sector operator. The spirit in the agreements is one of cooperation in delivering service rather than competition. In practice, areas of competition do arise and this leads to conflicts of interest.

For example, in the TelecomAsia and TT&T concessions, TOT was originally supposed to assign lines to subscribers. However, because TOT was unable to assign lines fast enough, the parties came to an agreement that TelecomAsia and TT&T would take over this function in the second half of 1994. At the time, it was possible for TOT to take this decision without conflict of interest because it had no available lines other than those from the concessions. However, in the near future, TOT will resume installing lines in competition with TelecomAsia and TT&T, and under these circumstances would presumably have been reluctant to cede the line assignment process to TelecomAsia or TT&T because it would have led to a loss of control over which subscribers become TOT subscribers and which subscribers become TelecomAsia or TT&T subscribers.

3.4. TOT and CAT Extract Economic Rent from Concessions

Under present concession arrangements, TOT and CAT gain revenue and profit shares from their concessions, that is they extract economic rent from their monopoly status as telecommunications service providers. In effect, customers of the private sector concessions are subsidising the inefficiency of TOT and CAT. There is no economic justification for this and it should be abolished.

4. Broad Consensus on Some Aspects of Regulatory Reform

Given the problems outlined above, there is general consensus that there needs to be regulatory reform of the telecommunications sector in Thailand. The previous government, which ceased in the second quarter of 1995 had developed a Telecommunications Master Plan of Reform. The new government has discarded that plan. However, there is consensus on some aspects of the reform.

4.1. Create an Independent Regulator

At present there is no telecommunications industry regulator. TOT and CAT have become defacto regulators of the industry, setting their own technical standards and their own tariffs and interconnect arrangements. They have also become the regulators of the concession agreements. There is general agreement that the role of the regulator should be vested in an independent statutory authority.

4.2. Privatise TOT and CAT

TOT needs access to increased capital to fund expansion. While it remains in the public sector, it will find it hard to raise that capital; the government will not invest extra equity and an already high debt to equity ratio makes it difficult for it to raise extra debt. The only solution is to privatise TOT. The advent of private ownership will also raise the incentive for much needed efficiency gains.

4.3. Licence New Service Providers

There is general appreciation that Thailand is falling behind other Asian nations in the level of competition in telecommunications. There should be more service providers licensed so that competition forces prices down and forces service levels up.

4.4. Convert BTO Concessions to Equity Holdings

Existing concessions are contractual agreements between TOT or CAT and private sector concessions. The revenue and profit shares that TOT and CAT extract

731

from these concessions will mean that the concessionaires become uncompetitive if other new licence holders do not have to pay similar revenue and profit shares to TOT or CAT. However, TOT and CAT will not want to give up their rights to these revenue streams without some compensation. The solution is to convert these rights into equity holdings in the private sector concessionaire. A precedent has already been set. UCOM has recently negotiated with CAT for the latter to accept 10 percent equity in UCOM's cellular carrier, Total Access Communications, in exchange for forgoing revenue share. Other concessions may be converted in the future.

5. Contention and Uncertainty Over Other Aspects of Reform

Although there is consensus on some aspects of regulatory reform, there is also strong debate over many other aspects. And it is this debate that caused the abandonment of the previous government's Telecommunications Master Plan. The debate covers a range of issues, including:

- Should the number of new licences be limited?
- Should licences be allocated for given geographic areas?
- Should there be periods of restricted competition?
- Should regulatory reform include regulation of the radio spectrum?
- How should regulatory reform address the convergence of different media?

6. Future Industry Structure will Gradually Blur Boundaries Between Different Services

As discussed above, the system of concessions has tended to fragment the industry in Thailand into many different companies offering specific, narrowly defined services. Despite this, the convergence between different services that is occurring around the world is also occurring in Thailand:

- Large conglomerates have formed which hold a number of companies each with a different concession. For example, Shinawatra owns companies with concessions for cellular, domestic satellite, paging, and subscription television.
- Other utilities are entering into service provision. The Provisional Electricity Authority and Metropolitan Electricity Authority already allow their electricity poles to be used for rights of way for local access networks, as does the State Railways of Thailand with its tracks for long distance transmission. The Electricity Generating Authority of Thailand is now considering joint ventures for long distance telecommunications transmission
- Both Shinawatra and UCOM are lobbying extremely heavily to become involved in the fixed wire local access and long distance business to complement their cellular businesses
- The potentially overlapping cable television networks will probably seek to enter telecommunications service by providing local access service as a way of increasing their revenues.

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[1] Senior Manager, Arthur D Little, Level 38, Governor Phillip Tower, 1 Farrer Place, Sydney 2000, Australia, Phone +612 247 9955, Fax +612 2473985, Internet parker.philip@adlittle.com

[2] Director, Arthur D Little, Level 7, Bank of America Tower, 12 Harcourt Rd, Central, Hong Kong, Phone +852 2845 6221, Fax +852 28455271

[3] Consultant, Arthur D Little, Level 38, Governor Phillip Tower, 1 Farrer Place, Sydney 2000, Australia, Phone +612 247 9955, Fax +612 2473985, Internet myles.andrew@adlittle.com

Lotus Notes: The '90s Solutions for Telecom Carrier Business Expansion

Larry Moore
Senior Vice President
Inter-Enterprise Communications Group
Lotus Development Corporation
Cambridge, Massachusetts USA

1. ABSTRACT

This paper describes an opportunity for public telecommunications carriers to expand their revenue base in an era of competition by providing their customers with a platform for business multimedia services. The Notes Public Networks (NPN) Services offers carriers a new class of Lotus Notes software that allows information to be accessed and communicated over public data networks both within as well as outside of traditional organizational boundaries.

2. INTRODUCTION

Dramatic new services and competition are transforming the global telecommunications industry and speeding our transition to an information based society. This is especially relevant to the development of the Pacific Rim as an important contributor to the global economy. In this evolving region, few public telecommunication carriers can afford to ignore the inevitable changes. Their customers rely heavily on their voice and data resources as information becomes the most sought after commodity on earth. The desire to receive information faster and more efficiently requires a flexible, easily accessible public telephone network. It must be able to support different types of voice and data as it helps businesses communicate and people work more efficiently -- no matter where they are.

For many companies, communication advances will enable them to reach customers by means of digital voice, image and video -- the building blocks of multimedia communication. Already, bank customers have become accustomed to using networked automatic teller machines to make deposits, get cash, and pay for groceries. Advanced transmission technologies are letting engineers around the world collaborate on multidimensional images for new products as though they were working together in the same room. Retailers are reordering goods as quickly as their stocks are depleted.

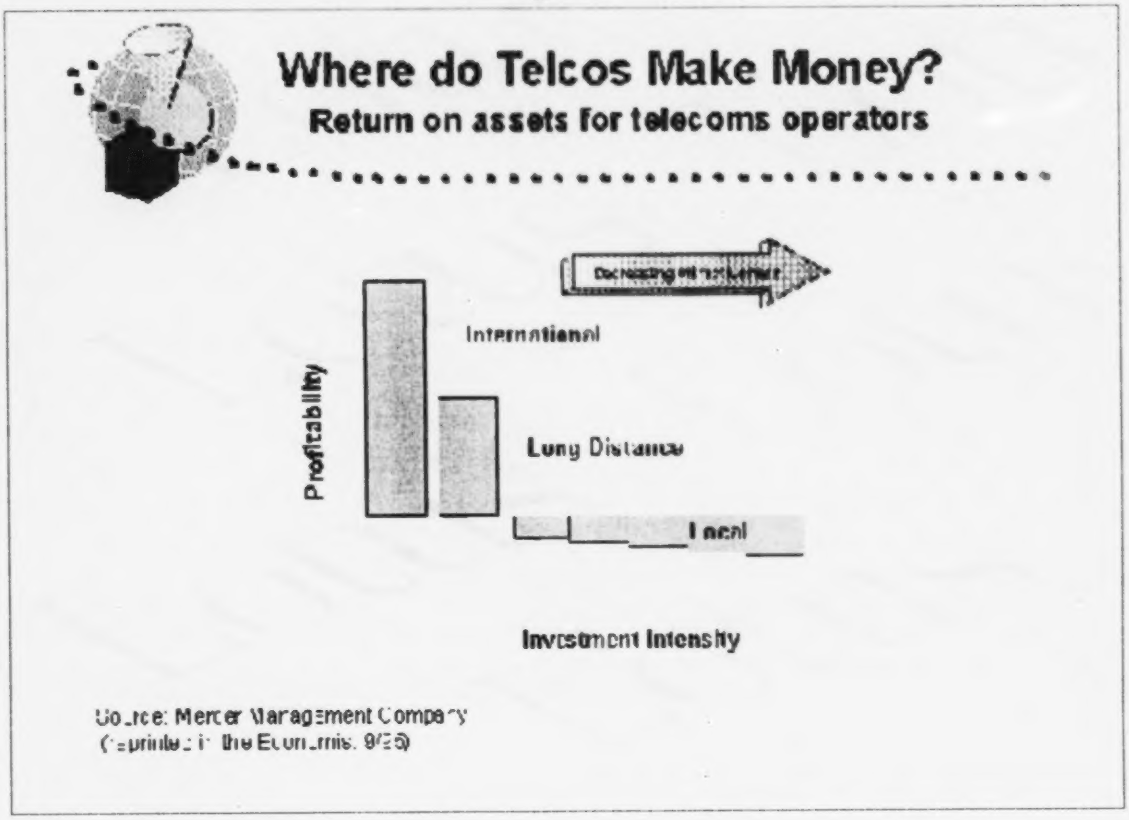
Competition is transforming every facet of telecommunications, ranging from telephone companies to cable TV, from long distance to broadcasting. At the same time, it is replacing regulation as the governing force. All of this is happening in an industry where public telecommunications carriers have recently become deregulated, privatized and highly competitive. For many, the deluge of customer demands is turning long distance and international telephone service into a commodity and creating the need for new and innovative services to fill the revenue void.

Deregulation, privatization, competition, and business process reengineering will continue to restructure the telecommunications industry. This is an industry that was built before the widespread use of personal computers, modems, satellites, fiber optics, and the much publicized Internet. It is an industry that, as it stands now, clearly needs to be modernized. Most public telecommunications carriers will have to rebuild their infrastructure. They will have to be able to offer the types of services that will offset the pressures put on their cash cow transport services by new competitors and networks, including the Internet. This becomes especially significant for many nations whose local telephone services are subsidized by long distance and international services (Figure 1).

The previously calm waters of telecommunications are being agitated by the arrival of new industry players who are offering both voice and data services. The competition now includes not only other public telecommunication carriers but also cable television operators, software manufacturers, banks, value added network service providers (VANS), and even utilities and railways. All are vying for substantial pieces of the $500 billion global telecommunications market. For the public telecommunication carriers this presents both challenges and risks.

The latest wave of digital technologies promises rich commercial possibilities. Many carriers in the Asia

Figure 1.



Where do Telcos Make Money?

Return on assets for telecoms operators

Source: Mercer Management Company
(reprinted in the Economist, 9/95)

Pacific region foresee a more liberalized marketplace and telecommunications infrastructure. These trends will promote the convergence of telecommunications with other businesses such as interactive multimedia services. They will provide new business opportunities that otherwise would not exist within Hong Kong, China, Australia and the rest of the region. For example, in Japan, it is estimated that within 15 years, their multimedia industry will increase by a factor of seven, outstripping that nation's formidable automobile industry. For public telecommunications carriers, new services offer the chance to offset the downward spiral of international call revenues -- up until now, their most profitable business.

However, the industry is also mindful that along with privatization, competition is inevitable. Those participants who do not move swiftly will rapidly lose ground with limited chances of catching up. Eventually, most of them must offer complete packages of communication and information services. That is what their customers want. They do not want separate and individual long-distance, local, cable, video and wireless networks. With the passing of time, modern public telecommunication carriers are being impelled to organize around markets instead of traditional regulatory structures.

3. THE INTERNET: THREAT OR SYNERGY?

If competition and privatization are not enough to contend with, there is also the threat of emerging networks such as the Internet that handle data as well as voice. The speed and reach of these networks both compete with and complement the public switched telephone networks (PSTNs) (Figure 2). Public telecommunications carriers are struggling to keep up with the success of the Internet. For those who are relatively unacquainted with it, the Internet or "Net" is a worldwide network of computers linked by telephone lines that provides inexpensive connectivity. Currently, 40 million people worldwide are using it for interactive communications. By 1999 this number will swell to 200 million. Commercial activity is centering on the World Wide Web, a graphical subnet of the Internet where multimedia information may be posted. Here, electronic advertising can reach a potential 25 million customers.

For many companies the introduction of the World Wide Web and hypermedia has transformed networks that were once restricted to specialists into enterprise tools. It is estimated that about 10,000 businesses per week establish an Internet presence and that the total number of Web sites is nearly one million. With voice and data offerings, the Internet is being used to target the most lucrative long distance services. Moreover, many companies that use the Internet primarily for communications are rapidly discovering that they can save considerable time and money by exploiting its electronic commerce potential. They now can link to their consumers in ways that bypass public telecommunications carriers.

The Internet alone is not sufficient for many businesses. They are justifiably concerned about its level of security. Until information on the Web can be protected to a greater degree, Web sites will remain principally informational and promotional rather than commercial. Only when a secure link can be established between the buyer and seller will the Internet's full marketing potential be realized.

If the Internet is to be used as a global transport network, than other limitations need to be considered as well:

- Bandwidth limitations: A single frame of video requires 150 Kb/s of bandwidth. Full-motion video runs 30 frames per second, taxing the capacity of the network.

- Database replication: Distributed databases must support business multimedia applications that share information interactively, not just in the form of an occasional download from a remote database.

Nevertheless, the reach of the Internet is too compelling to ignore. It offers local carriers instant worldwide access. Software companies, too, are learning that distribution via the Internet represents a paradigm shift from selling software as a product to selling software as a service. They are developing ways to provide the safety and database replication that the Internet lacks. They are also furnishing network management schemes designed along the lines of an internal corporate local area network (LAN), including client-server and workgroup

735

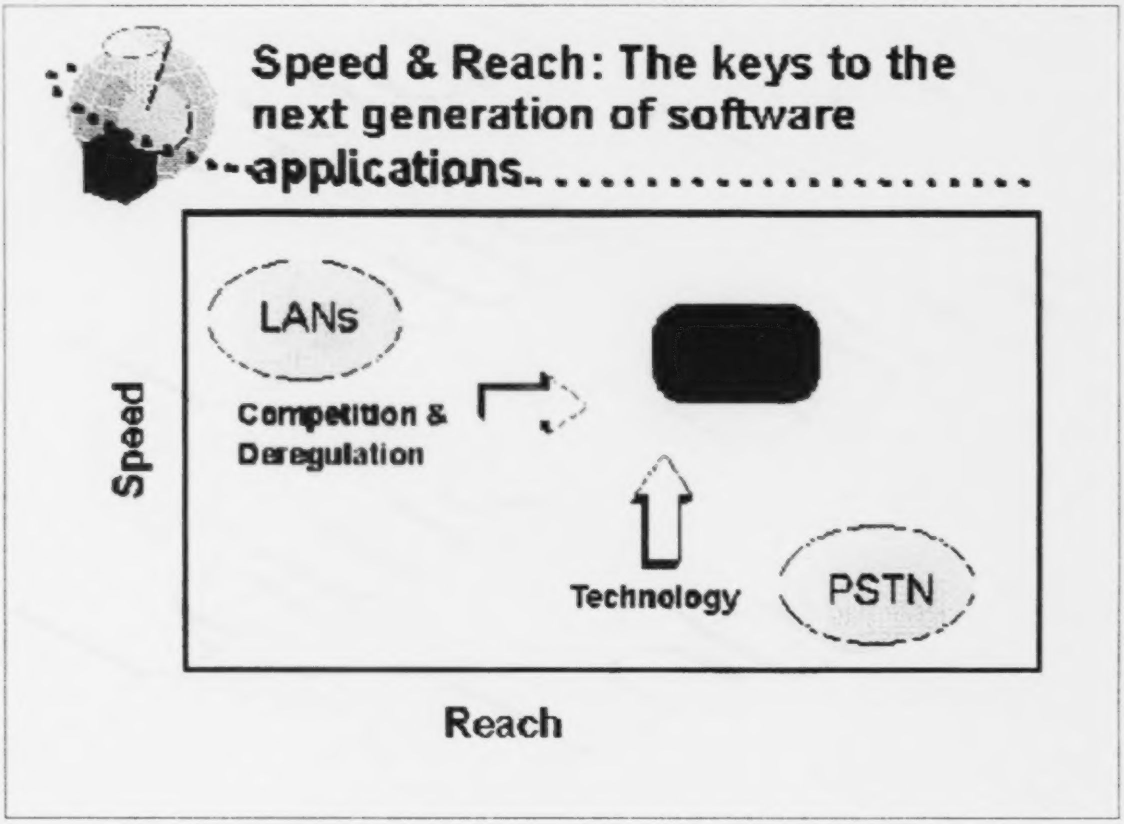


Figure 2.

Speed & Reach: The keys to the next generation of software applications..........................

LANs
Competition &
Deregulation
Speed
Technology
PSTN
Reach

applications. Lotus, the developer of Lotus Notes, the groupware standard, is a leader in the area. Public network carriers, too, are working to provide this capability. They are rapidly increasing the traffic on their own networks and the Internet by offering Notes Public Networks Services. This effort combines the strength of Lotus Notes with the value added networks and skills of the carriers.

4. NOTES PUBLIC NETWORKS: A COMMERCE PLATFORM FOR THIRTEEN CARRIERS AND GROWING

Thirteen public telecommunications carriers in Europe, Asia and the US are offering Notes Public Networks. The carriers -- AT&T, BT, CompuServe, Deutsche Telekom, IBM, Nippon Telegraph and Telephone, NTT Data Communications Systems, SNET, Telstra, Telecom Italia, Telekom Malaysia, Unisource and US West -- control 80% of global data communications traffic. To ensure that their services will interoperate they have formed the Multimedia Services Affiliate Forum. The Forum will specify standards for issues such as customer support, billing and security. Why do these industry leaders support Notes Public Networks? The answer emphatically lies in what Notes Public Networks can do for their customers.

Lotus Notes will soon incorporate features enabling NPN carriers to provide their customers greater scalability, reliability, and network management data. To date, there is no competitive product that will give a company's employees the same level of entree to up-to-the-minute shared information. With Notes, information of all kinds can be accessed from across the hallway or across the globe, no matter what type of computer or network is being used. However, while it may superficially resemble ordinary communications software, Notes is unique. It is the only software that has replication capabilities that allow multiple copies of information to be stored on distributed computers. This creates an integrated software platform for the public network management of voice, data and video. It facilitates interactive communication between people and machines while using the existing information infrastructure, including LANs, the PSTN and Internet. Notes is not an application but rather a platform for building and delivering applications. Financial institutions are using it to distribute investment information to customers. Researchers rely on it for comprehensive data. Help desks use Notes to respond quickly to customer requests. Sales groups find it extremely useful for tracking prospects and customers. Furthermore, Notes application development tools provide a framework for closer work cooperation. A user can create a document and then grant review, comment, and full edit rights to other members of the group. When the next user opens the document, it appears on his or her screen ready for editing.

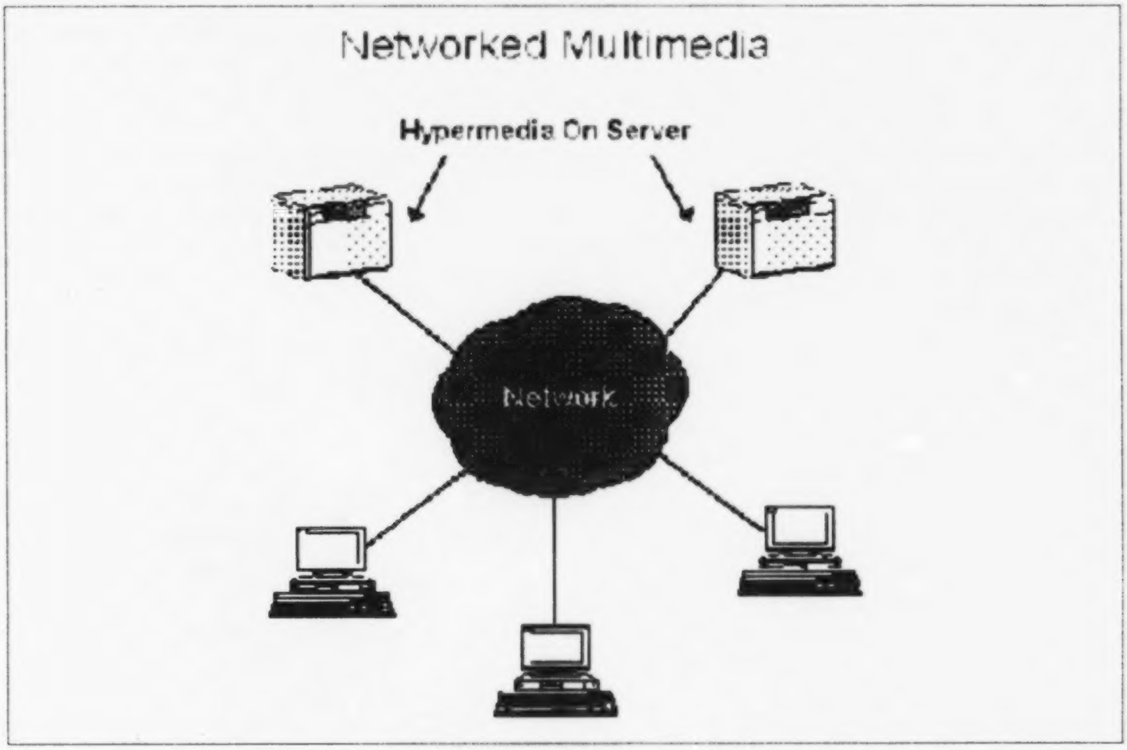
Notes provides an ideal platform for collaborative services among groups that are working together in joint efforts. It can be used to stimulate business and remove geographic barriers. What is most significant here is that it can be integrated into any legacy system. Notes services may be distributed over either the Internet or any carrier network.

5. MEETING THE REQUIREMENTS FOR MULTIMEDIA SERVICES

The full potential of the computer is close to being realized with multimedia services. These services take complete advantage of the computer's ability to transparently gather and present information in the most usable format. For business applications, the coherent presentation of multiple information streams -- voice, video, data, image, etc. -- provides a distinct competitive advantage. Multimedia changes workplace dynamics by providing new means of communications that can interrelate a variety of sources and types of information. Accordingly, there is an accelerating movement from personal to interpersonal communications, and from desktop multimedia to networked multimedia (Figure 3).

The stage is being set by workgroup software which transparently manages both the access to the networks as well as the content and services that flow across it. All types of devices -- personal computers, personal digital assistants (PDAs), digital televisions, etc. -- will be able to tap into the communication networks. With them, users will be able to access multimedia information and be connected to a multitude of on-line services. These new services will enable customers around the world to better manage and integrate

Figure 3.


Networked Multimedia
Hypermedia On Server
Network

complex and geographically dispersed enterprises. The services will also help them to strengthen their customer/supplier value chain, and expand into new markets.

Such services have to work across different networks. Therefore, the public telecommunications carriers must adopt a common service platform such as Notes Public Networks. This will enable the customers of one telecommunications company to communicate with the customers of other companies. The platform must support existing LAN applications as well as wide area network (WAN) transports such as the Internet. It must have a strong messaging architecture, and must be scaleable, manageable and dependable. Most importantly, it must come from a reliable vendor.

6. WHO ARE THE CUSTOMERS FOR MULTIMEDIA SERVICES?

The range of innovative uses for multimedia services challenges the imagination. Professional areas for which multimedia technology has become a valuable resource include education, health care, publishing, and financial accounting, among others. Speech recognition, imaging and videoconferencing are already being used for corporate training. They open up the possibility of developing very powerful services for businesses such as:

- Multinational companies seeking to establish global trading systems

- Large and mid-sized companies that want to outsource their network infrastructure

- Small companies that are developing "network based" businesses

- Consumers who need company information -- e.g., types of yellow pages or other publications that can be subscribed to over the Internet.

From the public network suppliers' point of view, multimedia services allow them to reach out to new customers. At the same time, they can offer existing customers additional sets of services. From the customers' point of view, public networks can be the key to rapid and safe roll-outs of large-scale inter-enterprise applications. From the point of view of entrepreneurs and individual companies, public networks can stimulate major opportunities for new and successful businesses.

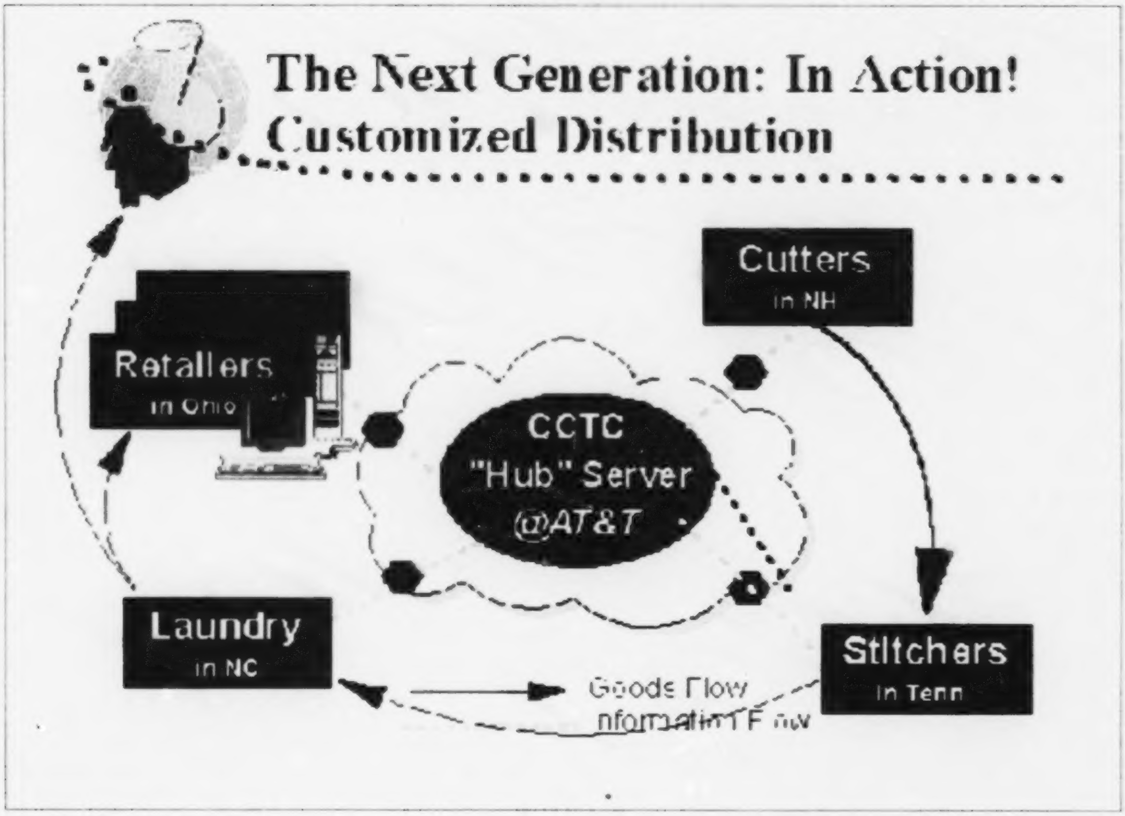
One entrepreneur, Sung Park, created a global, virtual company. His objective was to satisfy the market need for custom fitted women's jeans, and to do so economically and efficiently (Figure 4). Thanks to his company, a womna can go ino a retail shop or department store in the US that sells Levi jeans and offers this special service. After selecting the type of jeans that she likes, the customer is carefully measured. The style and measurement information is then transmitted through a Notes Public Networks Service to the fabric cutters in another geographic area. They, in turn, forward the fabric pieces to the stitchers who are at a third location. After the jeans are sewn, they are sent to be washed by a laundry at a fourth site. From there, the laundry ships the finished pair of jeans to the retailer for delivery to the customer. The customer is more than happy to pay a premium for this timely and much needed service!

7. MORE ABOUT NOTES PUBLIC NETWORKS

By using Notes Public Networks as a platform for inter-enterprise applications, public telecommunications carriers remove the burden of building and maintaining an internetwork from their customers. The carrier can "host" the application on its own server complex. It can add value in areas such as security, availability, management, hardware costs, mail gateways, and investment protection. It can also add business services, such as customer provisioning and setup, tracking and billing, and help-desk support. This was seen in the above mentioned example of the custom fitted women's jeans. In order for his business to succeed, the supplier, Mr. Park, needed to electronically interconnect all of the participants into the buying-manufacturing-delivery cycle

In a do-it-yourself situation, a supplying company would have to cross-certify and establish connections to each of its customers. It would also have to build its own one-to-many network. The company might be required to maintain hundreds or thousands of connections, thereby incurring the associated costs of supporting and staffing its own private network. In contrast, with a Notes Public Networks Service, the supplier need only establish and maintain a single

Figure 4.



The Next Generation: In Action!
Customized Distribution

Cutters
in NH

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in NC

Stitchers
in Tenn

Goods Flow
Information Flow

connection. The public telecommunications carrier furnishes the cost-effective, secure and reliable client-server computing and transport. The Notes Public Networks architecture is inherently designed for building and deploying secure inter-enterprise applications. Because Notes Public Networks runs on multiple platforms, public telecommunications carriers do not have to try to dictate their customers' client operating systems, server operating systems, or networks, including the Internet.

With regard to the Internet, the rise of the World Wide Web appears to have created an even more pressing need for Notes Public Networks. Although the Internet grants connectivity because it is an open system, today's Web server does not have the functionality of Notes. When they are used together, however, Notes over the Internet offers users a modular way to collaborate, manage documents, send and receive messages, and generally organize their workflow. As a tool on the Web, Notes can be used to create the content that is to be distributed to a myriad of users. Notes applications such as the Internotes Web and News servers allow a Notes server to act as a Web server. Finally, many of the capabilities that are built into Notes Public Networks are lacking on the Web. These include security, replication, full-text retrieval and an environment for development.

8. WHY CUSTOMERS BUY BUSINESS MULTIMEDIA SERVICES

Many business leaders are working fiercely to reinvent their companies.. The old way of organizing information with a centralized command and control hierarchy has often proven to be too inwardly focused. It was frequently overly bureaucratic, unresponsive to internal as well as external needs, and less than optimally productive. Its replacement, the reformed, distributed enterprise is still pursuing innovative ways to use information technology. How to migrate to the new multimedia services is now the most pressing strategic problem confronting most companies.

The reasons to migrate vary from company to company. Some businesses want to improve and cement ties with customers and suppliers. Some want to cut costs. Others need to reduce their dependence on scarce technical talent or to simplify the management of their infrastructures. The multimedia applications from which they can select are equally different. Some are concerned with the information flow between people and documents (e.g., hypermedia), between people and platforms (e.g., graphical user interfaces), or between people and people (e.g., collaborative activities such as training and conferencing). Others bring entertainment and games to the desktop. One common theme is the movement from standalone to networked applications.

9. HOW ARE BUSINESS SERVICES PRICED?

For public telecommunication carriers that are reeling from shrinking transport margins, the premium for Notes Public Networks Services will be a relief. Each carrier may develop a different service offering and pricing strategy to suit their own individual market, regulatory confines, and geography. One example is AT&T.

In addition to transport fees, carriers typically charge a monthly fee for server rental, and for dial usage (which is a per minute charge for server use). They also have the option of levying a fixed monthly charge for dedicated use. Dial-up users (local-dial access) of AT&T pay $39 per endpoint per month for up to two hours of use. An endpoint is a workstation or server that offers one or more users access to the service. (Additional usage is priced at $10 per hour.) According to AT&T, the cost per month will range from $25 to $80 per user with the typical user paying $40. Customers accessing the service through a 950-prefix number or an 800 number will also pay $39 for the first two hours of use per endpoint, and $12 and $13.50, respectively, for each additional hour. Endpoint billing allows information providers to offset application costs by generating revenues from customers who access their data.

10. WHAT DOES THIS ALL MEAN FOR ASIA PACIFIC REGION DEVELOPMENT?

The coming of age of global communications networks has removed geographic distance as a barrier to efficient contact between people, businesses, and nations. In this era of worldwide, multi-enterprise networking, the ability to employ the public telephone network has become crucial for modern commerce. All of this requires the coalescing of public and private networks. Therefore, public telecommunications carriers must make an investment in more powerful infrastructures that are capable of supporting the demands of multimedia applications. Only then will the growth of private corporate networks slow and be replaced by more efficient interconnections with the public network. However, the existing public network infrastructure on its own lacks the flexibility that new business applications require. Over time, users will want the desktop-to-desktop transmission of an assortment of multimedia information. As public telecommunications carriers' business customers become more global, they will want a single global carrier who can integrate all of the services. In response, Notes Public Networks, the PSTN and the Internet can create a worldwide network that will meet the communication needs of customers on any scale, and with any configuration and application.

11. CONVERGENCE OR COLLISION?

All of this is occurring at a frantic pace. Digital convergence is precipitating the merger of computers and communications with information delivery through diverse multimedia formats. It is creating new ways of doing business at the same time that it is influencing our commercial, entertainment, and social interactions. The business world will not only be able to perform vital operations faster, but will be able to accomplish much that could not be done before.

On command, Notes Public Networks Services offered by public telecommunication carriers will distribute communications between different types of computers and local networks. From the palmtop to the mainframe, from Beijing to Tokyo to Sydney, people and resources will be joined. Convergence will encourage faster and better decision making at the same time that it improves profitability and competitiveness. Taken together, all of these enabling technologies are allowing the WAN to become an extended-distance LAN. For the first time in history, information will be within the reach of all people who need it. The largest hurdles are not technological ones, but rather the will and ability of public telecommunications carriers to invest wisely in their real-time multimedia communications future.

Telecommunications Industry Dynamics

Massoud M. Saghafi, Ph.D.[1]
Center for Telecommunications Management
Graduate School of Business Administration
University of Southern California
Los Angeles, California 90089-0871

Telephone: (213) 740 0980
Telefax: (213) 740 1602

I. Introduction

No other industry in the United States has been as much under regulatory and public scrutiny than the telecommunications industry in the past decade. All three branches of the federal government have partial yet direct strategic and monitoring control over its activities. State regulatory agencies, a total of fifty of them, are also directly involved in the most minute aspects of the industry regulation from pricing to service offerings to investment decisions. In a mere ten years, an almost completely regulated industry has achieved a significant degree of freedom to control its destiny.

Five environmental factors influence the direction of the industry: regulation, competition, customers, markets and technology. Although the industry has partial influence over these factors, no single manufacturer, service provider or customer is in a decision-making position over them. Changes in any of these five environmental factors creates a new paradigm with a different set of rules for the industry. The proactive industry players may indeed predict the future trend, calculate the risk and plan their response to the expected environmental changes, ahead of competitors. ATT's recent break-up, partially in preparation for the potential telecommunications overhaul act of 1995 or Pacific Telesis' spin off of Air Touch, are such calculated risks. In the past however, the industry players have been more reactive than proactive in responding to shifts in the environment.

Deregulation, starting in 1984, has by far been the primary driver behind the industry advances. The divestiture of AT&T in the United States and its equals in the United Kingdom and several other industrialized countries and the ensuing competition, provided the financial incentives to innovate and reversed the monopoly-oriented mentality of the industry players with a competitive-orientation. During the first ten years after deregulation, the industry developed more successful telephone applications (e.g. call forwarding, call blocking, three-way calling, caller ID, call waiting, etc.) than its entire pre-divestiture history. Competition unleashed the unstoppable power of technology. In the 1990s, many NICs and LDCs joined the deregulatory bandwagon that gave rise to a truly global telecommunications industry.

As a result of deregulation, consumers worldwide, from large corporation to small businesses, from small residential to telecom-intensive telecommuters, from provincial to the largest branches of national governments, all enjoyed better and less expensive telecommunications and information services. Telecommunications services soon became commodities and competition between manufacturers and products offered, service providers and available services exacerbated. Price competition forced efficiency and multiple providers mandated reliability and effective delivery.

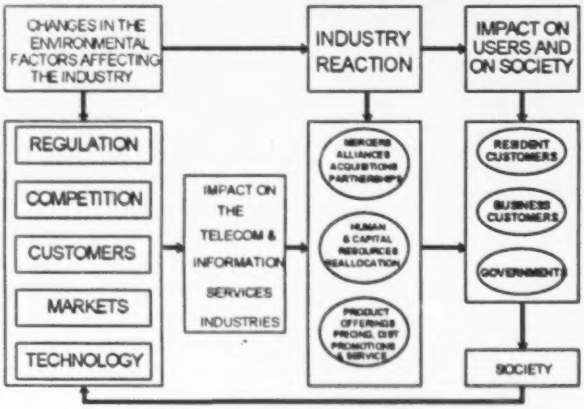
Historically, the telecommunications industry has reacted to environmental changes by forming alliances and strategic partnerships, through reallocating its human and physical resources (re-structuring) or by changing its marketing mix offerings. Any change in the industry, may it be downsizing, offering new products and services, price competition, vertical or horizontal integration or divestiture, typically affects the business, residential and government users, competitors in the telecom markets and other players in peripheral industries. The societal impact with a time lag, whether positive or negative, will in turn impact the environmental variables again which will rattle the

743

industry, generating another wave of reactions. This process is summarized in Figure 1[2].

Purpose. There are numerous exogenous variables that can suddenly change and significantly alter the nature of the paying field in the industry. Industry players should then attempt to predict the potential changes in the environment, pro-actively adjust their organizational structure, fine tune their human resources mentality and prepare to face the new realities. Doing so, they can better plan for the potential impact of their actions on users, competitors and society, can minimize the negative and highlight the positive. The purpose of this study is to point the dynamics of the telecommunications industry from an independent viewpoint over the next ten years.

FIGURE 1: ENVIRONMENTAL CHANGES, INDUSTRY REACTION AND THE IMPACT ON USERS & SOCIETY

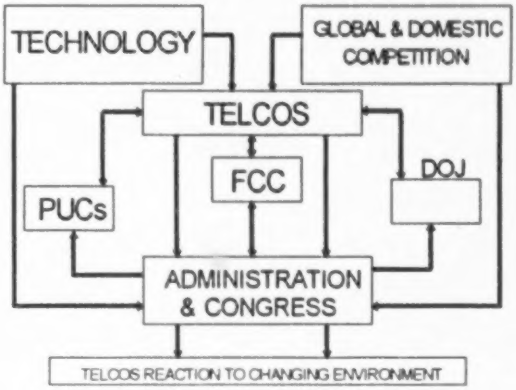

CHANGES IN THE ENVIRONMENTAL FACTORS AFFECTING THE INDUSTRY
INDUSTRY REACTION
IMPACT ON USERS AND ON SOCIETY
REGULATION
COMPETITION
CUSTOMERS
MARKETS
TECHNOLOGY
IMPACT ON THE TELECOM & INFORMATION SERVICES INDUSTRIES
MERGERS ALLIANCES ACQUISITIONS PARTNERSHIPS
HUMAN & CAPITAL RESOURCES REALLOCATION
PRODUCT OFFERINGS PRICING, DIST PROMOTIONS & SERVICE
RESIDENT CUSTOMERS
BUSINESS CUSTOMERS
GOVERNMENTS
SOCIETY

II. Environmental Dynamics

Regulation & Regulators. Regulation in the United States has taken a life of its own that exists virtually in no other nation. First of all, since the telecommunications act of 1934, there has never been a comprehensive telecommunications policy in the United States, until the current U.S. administration (1992) and Congress (1994). The National Information Infrastructure is perhaps the closest we have ever come to designing any national policy, yet even that is neither well defined nor well understood. The current 1995 telecommunications bill in front of the 104th Congress, if it goes through the House-Senate Conference in time, will have a tremendous impact on every aspect of the industry, both at home and abroad. Nevertheless, with all of its new "market-oriented" changes, the industry will still remain under regulatory pressures from *all* government branches. Figure 2 displays this regulatory environment that will hold power over the industry, even after the passage of the telecommunications overhaul bill.

Some of the most important regulatory changes are in the redistribution of regulatory power itself. First of all, the U.S. Congress will be taking a more active role in reshaping the future of the industry, confirming its commitment to a truly competitive telecom market. Second, even though the Justice Department will still insure that the anti-competitive laws are not violated, its power over the telecom industry will be tremendously reduced in the near future. Third, regulations will become more national implying a stronger position for FCC and a relatively less powerful role for the state PUCs over time.

FIGURE 2: REGULATORY ENVIRONMENT & TELCOS


TECHNOLOGY
GLOBAL & DOMESTIC COMPETITION
TELCOS
FCC
PUCs
DOJ
ADMINISTRATION & CONGRESS
TELCOS REACTION TO CHANGING ENVIRONMENT

However, the industry may be headed toward another round of re-regulation on several new fronts. Abusive telemarketing practices; violation of the societal norms on the electronic and traditional media such as sex and violence issues on T.V. on the internet (the V-chip issue); infringement upon individual privacy, copyright and trademark violations on the internet; secure data transfers; wireless spectrum and many others, may arouse the public to press for further industry regulations.

On a broader sense, cable and some broadband services may soon be considered a *right* and a necessity for all Americans rather than a *privilege* or a luxury as the U.S. rapidly moves towards an information-based economy.

This opinion may result in a universal cable and broadband act similar to what currently exists for the basic telephone services and may put the providers in a precarious position. With domestic and global competition flourishing, the industry may again find itself falling into a non-competitive position.

Competition The de-regulatory trend on the one hand and the technology on the other, will create domestic competitors from within the global telecommunications industry and from other segments that are not even considered at this time. For example, ten years ago, it would have been unusual to speculate that public utility companies may threaten telcos with their telecom capabilities or to imagine that the private networks of large companies can one day pose a competitive challenge to the strong business customer base of the local exchange carriers.

Today, these are not only facts but companies such as British Telecom, Times-Warner, MCA, Sony and others, are poised to chip away the solid dominance of the RBOCs in various areas of their core business. The long distance market is becoming open to the local exchange carriers and vice-versa[3]. Cable companies compete with telcos to deliver telephone service to residential customers and vice versa. international companies will soon be allowed directly into the previously sacred U.S. local loop market. Manufacturing has become a fair game. All the above, plus the advances in the wireless technology, have drastically changed the telecom industry's competitive landscape. Alliances have become a necessity to survive and productivity improvement is not a luxury anymore.

Competition among methods of delivery of telecom services to end users favors fiber optics as the short-term solution to reliable and quality video transmission. In the longer time, the balance will clearly tilt toward wireless (PCs, digital cellular, satellite, etc.) device and equipment manufacturers. There may be even a day in the near future that the wired telephony become the redundant emergency global network.

There is no doubt that the telecom and information providers will from colossal mega-mergers to become one stop voice-video-data providers and then many will vertically integrate to generate what they deliver. As telecommunications services become commodities, volume-driven and undifferentiable, price becomes an even more crucial competitive weapon. To gain competitive advantage, many U.S. companies were forced to leave home for Asia-Pacific or Latin America for commodity-like manufacturing operations in the 1970-80s. International telecom *bypass* in 2000s may become analogous to manufacturing bypass of 1970s. This time however, U.S. may indeed have the comparative advantage in inexpensive information generation and transmission over practically any other country in the world and may become the net gainer of the telecom bypass.

Customers and Markets The next two environmental factors influencing the industry are the demanding global customers and the dynamics of the telecom product-markets. Not only the customers are changing (e.g. the gap between small business and residential customers is narrowing) but their demands are changing faster than what the traditional telcos are capable of providing. For example, the customers need for secure wireless voice transmission, privacy, or flexibility cannot be met by most telcos that have never been exposed to such a large lead-user customer line-up. This has opened the door to small, innovative and entrepreneurial niche players in the industry.

New markets are evolving with totally new demands for service. Vietnam is one such example. With a massive backlog of demand for basic telephone service and up to ten years of wait for acquiring one, many Vietnamese have bypassed the traditional providers to the wireless alternatives. Companies such as Qualcom have suddenly found success while the traditional wireline providers are astonished by the insatiable and impatient crave for a plain old telephone service in so many low- income countries.

The telecom and information market potentials are a source of envy for most other industries. Multimedia services will soon be a $30 billion revenue market, the on-line data exchange market and wireless voice services are growing at unprecedented rates, the toll free market will grow to over $15 billion in the U.S. alone, within a decade, the video-on-demand expenses of an average American household will surpass its entire voice-data bill and the major PTTs of the Pacific and many LDCs will privatize and will open up a $600 billion market to global competition. The long distance market in the U.S. will reach $150 billion, the local (including access charges) will surpass $90 billion and the large American companies will spend at least 5% of their corporate costs on telecommunications services[2]. The financial services industry, banking and insurance have currently reached that level. The clear winner of all these changes will be the end users.

Technology Perhaps the most important environmental change that has taken both the industry and the customers by surprise, has been the generation and diffusion of new telecom and information technologies. In the past ten years, there have been more new telephone service offerings in the United States than during the entire 20th Century and the rate of new product and service introduction in the overall telecommunications sector is not declining. Neither the telcos themselves nor their customers have been able to keep up with the scientists and engineers and have fallen years behind the newest technical advancements in the industry.

First of all, with the regulatory push to replace copper with fiber, a whole new range of broadband opportunities will soon arise for the service providers. Video will perhaps benefit most substantially from the change in infrastructure as the society moves to a glass-based transmission era. At the same time, the compression techniques will allow significant arrays of voice and data transfer even without the use of fiber optic lines.

The most significant technological advances however, may not even occur on the hardware side. Software development will allow computers to talk and will eliminate the language barriers for machines and for humans. For example, you can write a memo in English in your office in the United States and send it via E-Mail to your subsidiaries worldwide instantaneously in their local languages. Even better, with voice recognition, automatic message translation and video-conferencing technologies, you can have a telemeeting with your partners worldwide, everyone can speak its own language, yet everyone receives the messages and the forms in their language of choice, in real time, in real size and in full motion in their offices. ATM, optical switches, Broadband ISDN and Open Network Architecture will all be widely used allowing light-speed transmission of voice, data and video, eliminating an entire array of services currently in place and will introduce users to a truly virtual world without virtual limitations.

Will the large business customers be ready for the environment at the end of this decade? Perhaps yes. Will today's traditional telcos be prepared to serve their current customers in that era? No, unless both the companies and the regulators begin drastically changing their mentality soon. Finally, the most important question of all: will the society be ready for that era? It is ironic that even in the next ten years, a large number of today's technologies will be in the process of deployment rather than obsolescence. For example, only 10% of the American homes will be firbered, only 25% of them will use ISDN-type services and only 15 million Americans will use the video-audio technologies to telecommute[2]. Video communications and other advanced interactive broadband services will barely make it into the living rooms or the home offices of American families even in the next decade.

The major defining moment that can alter the entire telecom and information industry is advancements in end-to-end wireless voice, video and data transmission technologies. The Iridium project creating a 66 to 72-communications satellite system orbiting the earth and covering every square meter of it, multi-mode digital cellular telephones, radio spectrum slicing technologies, global wireless standards, etc. will soon redefine the telecom and the information future we will live in.

The most important technology of the 1980s to be mass deployed and fully exploited in the next ten years will be the internet and on-line information and entertainment services. Multimedia, virtual reality and video on demand will be used frequently and will generate a significant revenue stream for their providers. In short, the family rooms of tomorrow will be the site where most applications of current technologies will emerge. Of course, there is no reason why the internet-based telephony will not become the conversation mode of tomorrow.

III. Industry Reaction

Although each industry player has reacted differently to the changes of the past ten years, practically all have pursued a common reactive strategy in the following three area:

1. improving productivity through cost cutting measures, especially by downsizing the workforce,

2. forming strategic global alliances and joint ventures with new partners to raise capital; mergers and acquisitions to access new product-market, to get easier entry into new markets, or to acquire new technologies, and

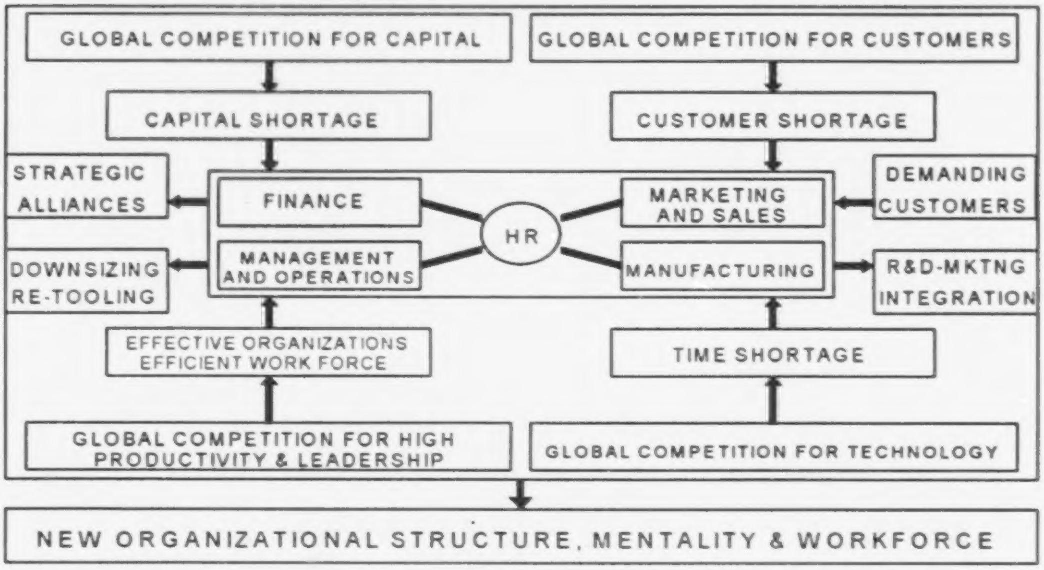
3. developing new products and services to differentiate offerings and repositioning of corporations in the forthcoming competitive global marketplace.

Organizational & Mentality Re-Engineering. Figure 3 depicts the impact of environmental changes on the internal organization of telcos. To remain cost-competitive, the industry has already cut its labor force by 15% over the past three years. This work force reduction is expected to continue throughout this decade. Access to the distribution networks of competitors, to gain technological superiority or to enter new product markets, have encouraged the telecom companies to join forces in the form of joint capital ventures to remedy capital shortage, strategic alliances or licensing agreements in order to achieve presence in other markets and to innovate new products and services to differentiate themselves.

Mergers, acquisitions and alliances. Given the blessings of the regulators, the trend towards a true market-driven telecom and information industry will continue into the future. To expand, telcos need to raise capital, enter new markets and reach new customers, all in a short period of time. Strategic alliances, mergers and acquisitions, are in many instances the least painful and most expedient expansion methods. Obviously, telcos will enter into contractual agreements with content providers, cable operators and some even with publishers, entertainment companies and satellite services providers.

Human-Resources Reorganization. To improve productivity, the local exchange carriers will reduce the labor force by another 20% while the information industry will add at least 10% to its workforce in the next decade[2]. Competition and a more demanding cadre of customer will push the management of telcos to expedite plans in favor of customer-driven organizations and workforce and to develop programs in support of boosting the morale of their employees. Telcos will also increase investment, spending at least 5% per year of their annual sales to modernize networks in preparation of entry into the long distance market, equipment manufacturing, information services and most importantly, to provide entertainment to American households. New product offering by telcos will increase significantly over the next ten years.

FIGURE 3: REACTION TO ENVIRONMENTAL CHANGE


GLOBAL COMPETITION FOR CAPITAL
GLOBAL COMPETITION FOR CUSTOMERS
CAPITAL SHORTAGE
CUSTOMER SHORTAGE
STRATEGIC ALLIANCES
FINANCE
MARKETING AND SALES
DEMANDING CUSTOMERS
HR
DOWNSIZING RE-TOOLING
MANAGEMENT AND OPERATIONS
MANUFACTURING
R&D-MKTNG INTEGRATION
EFFECTIVE ORGANIZATIONS EFFICIENT WORK FORCE
TIME SHORTAGE
GLOBAL COMPETITION FOR HIGH PRODUCTIVITY & LEADERSHIP
GLOBAL COMPETITION FOR TECHNOLOGY
NEW ORGANIZATIONAL STRUCTURE, MENTALITY & WORKFORCE

IV. Summary

To summarize the presentation, a BCG-type model is provided. As Figure 4 explains, the stars of the industry center around the long distance and the toll-free markets. Both are large and growing. Even though the personal 800 number in its introductory stage, combined with the business toll-free market, they will command over $20 billion revenues. There are smaller markets that have high growth potential. Home-entertainment, multimedia and the internet services are few of those smaller yet high growth sectors. The local exchange market falls in the "cash cow" category. Such products, services or software that will enhance electronic commerce through improving its ease of use, security and privacy and reduce the risks of trademark and copyright infringements will be all relatively small but have significant future potentials. The future however, belongs to wireless voice, data and video services and devices (e.g. wireless fax). The industry should not underestimate the power of technology to overcome all the existing quality and variety issues surrounding wireless products and services. These will all be resolved in the next twenty five years or sooner.

FIGURE 4: BCG-TYPE MODEL FOR TELECOM INDUSTRY

		REVENUE GROWTH	
		LOWER	HIGHER
SIZE	LARGER	LOCAL EXCHANGE SERVICES MARKET TELECOM HARDWARE MARKET	LONG DISTANCE & 800 TOLL FREE MARKETS CONTENT PROVISIONING
	SMALLER	VIEDOTEX & SIMILAR SERVICES VIDEOPHONES & SIMILAR PRODUCTS	INTERACTIVE HOME ENTERTAINMENT ELECTRONIC COMMERCE & INTERNET

The future of the telecom industry can be summarized as follows.

1. The unstoppable trend toward interactive wireless voice, data and video transmission will only exacerbate.

2. The trend toward completely deregulated, market-based pricing and open competition with the exception of a to-be-defined universal services will continue.

3. A strong trend toward vertical and/or horizontal integration in the broader industry, including LECs, IXCs, CAPs, Cable T.V., content providers, manufacturers, etc. is underway that will lead to large global telecommunications, information and entertainment companies that will produce and deliver voice, video and content to consumers.

4. The need for a new set of high quality and private wireless devices, secure and intrusion-free electronic commerce services, legally and socially acceptable internet content will turn into a multi-billion dollar venture.

5. The industry will reduce employees per company to achieve efficiency and higher productivity levels but the employment across the industry will grow due to the significant rise in demand for telecom and information services. Telecommuting by itself, will become a major growth sector demanding a completely new set of services in the near future.

V. Endnotes

[1] The author is also a professor of marketing at the San Diego State University.

[2] Adopted from: Jagdish N. Sheth, Massoud M. Saghafi and Robert M. Janowiak (1994), *Telecom Outlook Report*, Executive Summary, Page 4.

[3] Much of the vocabulary used by industry players such as "local" and "long distance" inerLATA and intraLATA, Cable T.V. companies versus POTs, etc., have regulatory roots and date back to the pre-divestiture era. The time will soon come when these distinctions should be dropped. Voice, data and video will be transmitted regardless of who does it and whether it came from the local switch or from a satellite thousands of miles away.

TELEVIDEO BUSINESS IN KOREA TELECOM

SUNGOH MIN
Korea Telecom
Seoul, Korea

1. ABSTRACT

Conventional telecommunication services such as POTS (Plain Old Telephone Service), facsimile and videotex have gradually evolved toward multimedia service which can deliver any combination of voice, data, text, graphics and video. As a typical example of this evolution trend, Korea Telecom has recently developed the "Televideo Service" that may be the first practical multimedia service. This paper will cover the experience and the lessons learned through the operation of the technical trial of "Televideo Service" and the selected topics: background of emergence, project strategy, system configuration, contents, services, subscribers' responses, and lessons. The fruitful outcome of the first phase project will play a crucial role in applying various multimedia-related services to the information superhighway infrastructure or Broadband Integrated Service Digital Network (B-ISDN).

1. BACKGROUND OF THE EMERGENCE OF VIDEO DIAL TONE (VDT)

There are many ways to deliver information including audio, text, image, and video. Among these, perhaps the most efficient form of delivery system is the video. Typical forms of video service include TV broadcast and video teleconferencing. Recent leap-frog advances in information technology have brought about a series of revolutions in the video service industry. In the broadcast area, new and better services such as CATV with a higher number of channels, digital satellite broadcast and High Definition TV are emerging as viable alternatives to overcome deficiencies of the existing analog TV broadcast system which is limited in the number of broadcast channels, coverage area, and picture quality, encouraged by technological advances in high speed transport products and video signal compression devices, new video telecommunication services such as distance learning, remote medical diagnostics, video teleconferencing,and Video Dial Tone (VDT, which is also known as Video On Demand (VOD), details of this service will be discussed later) are also being developed in the telecommunication area. In the consumer product area, Multimedia PC(MPC), equipped with the capability to handle audio, image, video and almost any other form of data is emerging as the leader of the PC market. Also 3DO games and terminal devices that can reproduce video CD are rapidly penetrating the consumer market.

Although the video is humanity's most efficient means of delivering information, the information volume of video is much larger than voice or data signals. Hence it is much more difficult to process and store the video contents by computers and to transport via telecommunication networks. However, recent advances in video compression technology and high speed transport technology have enabled us to overcome the difficulties and made the multimedia service era possible.
When an analog video signal is converted into digital video signal, the resulting digital signal format is 45 Mb/s (Mega bits per second). In order to store this kind of high volume

749

information, a memory device that can handle 5.6M Bytes of data per second would be necessary and only about 2.5 minutes of the video content could be stored on one side of a 12cm diameter CD. The cost of processing and storing such digital video information would be prohibitively high due to the staggering memory requirement. A recently developed video signal compression method known as MPEG I can compress the original video signal by a factor of 30 (1/30), reducing the information format to 1.5Mb/s and enabling the recording of 74 minutes of video information on one side of the CD. Since the establishment of MPEG I standard, essential IC chips for encoding and decoding have been available on the commercial market enabling rapid and rampant availability of MPCs and CD video titles that can handle full-motion video.

Almost simultaneously in the telecommunication area, a new transport device known as ADSL (Asymmetric Digital Subscriber Line) that can transport a MPEG I compressed digital video signal from a telephone company's Central Office to subscribers' premises via existing two-wire copper twisted pair has been developed.
This new device enables the transport of compressed digital video contents from the storage device of a video server, which is a special computer, to the subscribers' premises via plain old telephone wire and the ultimate reproduction of the original video on an ordinary TV screen through a decoder(DET) that decompresses and converts the digital signal into an analog signal suitable for viewing on a TV set.

2. TELEVIDEO SYSTEM CONFIGURATION

The fact that a subscriber can access the televideo service instantly and immediately at any time "on demand" makes this service the most advanced form of state-of-the-art interactive media. The system configuration to implement this service is illustrated in the Figure 1.

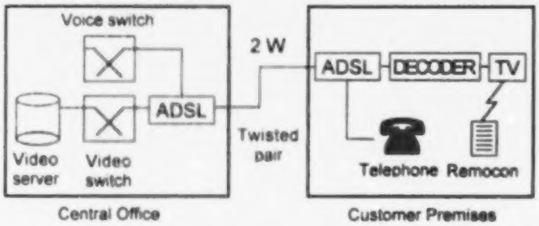


Fig. 1 Televideo System Configuration Diagram

The basic building blocks of the system are a video server that stores and releases video contents, a video switch, a high speed transport device(ADSL), and an interactive terminal (decoder). The video server is basically a kind of a computer.
The difference between an ordinary computer and the video server is that the primary function of an ordinary computer is to process or manipulate data, whereas the primary function of the video server is the storage management of the video contents and input/output capability so that a large number of subscribers can be served simultaneously in real time by providing multiple active video streams retrieved from the storage media.
The performance of the video server is rated in terms of the maximum number of active video streams from a single server as well as in terms of the maximum number of simultaneous active video streams from a single copy of a video title in the storage media.

ADSL is a kind of high speed modem that is capable of transporting simultaneously the voice signals from the telephone exchange multiplexed with the video streams from the video server via local subscriber telephone network. This device also carries out the task of bi-directional transport of control signals and program request signals from the subscriber.

The primary function of the decoder as a customer premise equipment is to reproduce the original analog video signals from the MPEG I compressed format and to transport control signals from the subscriber to the video server thereby making interactive TV service possible. The operational procedure for receiving the service is as follows: When the subscriber turns the power switch of the remote control unit on, the early menu will be received and displayed on the TV screen. By navigating via remote control unit, when a desired video title is selected, the select request signal will be transported to the video server through the decoder, ADSL and video switch, and the retrieved video stream will be transported to the subscriber in real time. The telephone portion will be separated from the video stream at the remote ADSL unit via a passive POTS filter and the POTS service will be intact while video service is in operation, that is, in and out bound ordinary telephone service will be unaffected.

3. TECHNICAL TRIAL OF TELEVIDEO (VDT) SERVICE

The Televideo service can be defined as an interactive TV service because an immediate viewing of a desired program is possible on demand once the desired video program is selected. In advanced countries, if the service is limited only to movie titles, it is known as VOD(Video On Demand) and if additional services such as drama, karaoke and other video titles are offered, it is known as VDT (Video Dial Tone). At Korea Telecom, the service is called "Televideo" because the video is transported via existing telephone circuits.

Because such VCR like functions such as Play, Fast Forward, Rewind, and Pause, etc. are possible via a remote control unit, the service is called interactive. As conventional ways of delivering the video, existing analog TV system is a broadcasting delivery system in omni-directions of limited channels to unspecified mass subscribers and CATV is another broadcasting delivery system of a variety of programs through wire lines using much more channels than analog TV system. However, both systems have inherent inconvenience of not being able to offer the service on demand at any time of the subscriber's desire and choice.

A system that can overcome the inconvenience has emerged known as NVOD(Near Video On Demand), it periodically repeats the same program at a regular interval. With NVOD subscribers can view the selected program within a certain amount of time after making their request. Hence NVOD is slightly more advanced than CATV and is a limited interactive TV service fairly close to VOD service.

Table 1. Relationship Between CATV/NVOD and VDT

Type / Feature	CATV	NVOD	VDT
Subscriber Type	Unspecified Mass	Specified Users	Specified Users
Delivery Method	Broadcast	Broadcast	Communication
Interactivity	None	Limited bi-directional	Bi-directional
Request program	Impossible	Possible	Possible
Latency to Reply	NA	30 Minutes or longer	Less than a few seconds

In order to verify the technical possibility of the Video On Demand service that requires complicated system integration technology, Korea Telecom started, in November 1994, offering the technical trial service to about 100 subscribers in the Panpo area of Seoul, including telecommunication specialists, employees of KT, selected customers, and employees of multimedia-related companies.

One hundred hours of video contents, a total of 142 titles covering 7 categories including movies, drama, sports, travel, education, karaoke, and culture, are encoded in MPEG I and stored in the video server.

The on-demand video services are graded on the basis of two parameters: one is the latency after the service is requested by the subscriber and the other is the maximum number of subscribers that can view the video at the same time.

The salient feactures being offered in the trial service are as follows: the latency to receive video information after the desired video title is selected from the menu in text form is less than one second, the maximum possible number of subscribers that can view the same video title from a single copy is six, and the maximum number of active video streams that the server can support at any given time is 30. The maximum distance between KT's Central Office and a subscriber over which MPEG I video signals of 1.544 Mbps can be transported without unacceptable distortion, has been verified at 3.2Km. During the early phase of the trial, frequent occurrence of blackout of the video from the TV screen and video quality degradation took place, but now that the software bugs have been fixed, the current system is quite stable and operates under normal conditions.

A recent survey of the users indicates that of the seven categories of services offered, movies and karaoke enjoyed relatively high viewing rates and the average daily usage was about one hour and was quite constant throughout the week. Relatively few complaints were received about the technical performance such as the latency and equipment troubles. The major complaint was the lack of variety of video titles. Therefore in order to satisfy customers' demand for more video titles, the frequent replacement of video programs is an important requirement that needs to be resolved. Although the trial system installed at KT is relatively small in capacity and scale and can only serve a small number of subscribers compared with the large systems being deployed in advanced countries such as the United States and United Kingdom, a complete interactive service has been realized by integrating a broadband multimedia video switch and a relatively inexpensive video server. Compared with the earlier VOD trial system in the United States that did not achieve full Interactivity because the title selection was done by a separate telephone call, KT's current trial system is regarded as somewhat more advanced form because a full Interactivity is supported via a remote control unit of the decoder and a full range for VCR like functions is supported.

4. TELEVIDEO MARKET TRIAL SERVICE

To prepare for its eventual commercial marketing, Korea Telecom plans to expand the initial trial system to 1,500 subscribers in six major cities throughout the country and the expanded service beginning in February 1996. The new market trial service will include home shopping, electronic newspaper, video games, and a variety of multimedia-related application services, etc. in addition to movies.

To implement those services, some of the salient features of the new system are as follows:

- CPE terminals are TV sets or Multimedia PCs
- Central management system in Seoul via interface network of all sites
- Remote downloading capability of video contents from the central management system to all remote sites when contents are updated
- MPEG II transport capability of various video, graphics and data
- Two hundred hours of storage capacity of video contents in the server
- Menu screen is improved from text only to image format
- Forty simultaneous viewing of the same title from a single copy is now possible
- Implementation of Level 1 and 2 Gateway functions.

From the service-platform point of view, the fundamental difference from the technical-trial system lies in the adoption of Digital Audio Video Interactive Decoder(DAVID) Version 2.0, which offers the most updated Application Programming interfaces(API) commercially available in realizing various multimedia services. Powerful authoring tools based on Multimedia Application User Interface(MAUI) are given to 24

Video Information Providers(VIPs) for creating and designing a variety of contents regarding market-trial services.

5. BUSINESS STRATEGY

5.1 ESSENTIAL SERVICE TO BE APPLIED TO INFORMATION SUPER-HIGHWAY

To prepare for future information age, most advanced countries such as the United States, Japan and many European countries have announced plans to construct information super highways, although the name and the overall scale may be different from one country to another. And major efforts are already underway as national projects that go far beyond the government level.
Taking into consideration the network development trend in advanced countries, the Korean government also established a master plan to implement nationwide fiber to the home network by 2015 and the Asynchronous Transfer Mode(ATM) technology that can provide flexible switching capability to handle various multimedia information. In some areas the information superhighway network is already under construction as a joint project among the government, industry and academics.

Two major broadband services to be offered over the information superhighway are the broadcast (distribution) and communication (interactivety) types. The latter is generally regarded as being more advanced because with the communication type the user can send and receive, to and from the source, messages in both directions whereas with broadcast type only unidirectional delivery or distribution of information is possible.

In Televideo (VDT) system, a broadband video signal is transported from the network to the subscriber and a narrowband control signal is transported from the subscriber to the network, therefore it is an asymmetric system and also a communication service because the stored video contents can be retrieved and viewed as many times as desired.

The VOD service is the essential basic multimedia service that can be deployed over the information superhighway as a representative interactive TV service. Korea Telecom anticipates that more than 80% of the network will be used for video delivery beyond 2000 when the information superhighway and B-ISDN are in place and to meet the anticipated future demand. Televideo (VDT) business was adopted as a strategic part of an overall diversification plan.

In the early phase of the broadband service business, the multimedia revenue will be generated by offering the technical trial service, home shopping, electronic library and various application services and in more mature phases expansion into symmetric services including video teleconferencing, video phone and video mail, etc. is also planned.

5.2 STEP BY STEP DEVELOPMENT OF TELEVIDEO BUSINESS

Taking into consideration the fact that even in advanced countries the service implementation faces many difficulties because the necessary technology and equipment are now under development, relatively small investment in limited areas was made to minimize risks but to maximize publicity. Once the market demand for the service, is created, mass deployment of VDT service throughout the country is planned in three steps: 1) the technical trial; 2) the market trial; 3) the commercial deployment. During the initial trial period, adaptability of the service over existing copper plant and technical issues were tested, verified and analyzed. During the market trial period, we plan to establish a new video market by creating demand through efficient mobilization of private sector creativity to supply a multitude of application services. For mass commercial development, an overall network of copper plant and fiber will be constructed to be able to support the full service. A step by step strategy for offering full scale service is planned.

Table 2. Korea Telecom Televideo Business Build-Up Strategy

Steps	Period	Service Area	Number of Subscriber	Services Offered
Technical Trial	1994.11 - 1995.12	Panpo Area Seoul	100	Televideo
Market Trial	1996.1 - 1997.6	6 Major cities	1,500	Televideo, Home shopping, electronic newspaper, distance learning.
Commercial Deployment	After 1997.	Nationwide	15,000	All application Services

5.3 DEVELOPMENT OF SERVICE APPLICATION UNDER THE GUIDANCE OF PRIVATE PROGRAM PROVIDERS

The main core of the VDT service is to allow subscribers to access the contents stored in the video server(various video and multimedia database) in a speedy and convenient way. Because the offering of a variety of video service, requires the editing and production of various video information and the development of an access graphic menu suitable for the service characteristic, cooperation with video service providers is required. For the cooperative development of application services, the work has been divided. KT offers service providers use of the memory within the server, authoring tool, and software platform. The service providers in return develop multimedia services utilizing their creativities to the maximum extent through production of multimedia database and video programs.

Through a public announcement in April 1995, KT selected 24 VIPs, who are now working on the purchase of the necessary video equipment and development of content. Several such developed applications will be provided from February 1996.

Table 3. Development Details for Different Services

Service	Details of Developed Material	Number of VIPs
Education Information	Middle and high school courses, life English, TOEIC, computer for everbody's use, Korean culture, etc	10
Home Shopping	Movie guides, CD titles, automobiles, real estate, various consumer goods, daily necessities	9
Electronic Newspaper	Book guides, professional technical information	2
Games	Commercial games, general knowledge, educational quiz cartoons	3
Miscellaneous	Travel information, medical information, sports	6

6. TEST TRIAL AND LESSONS LEARNED

The main purpose of the mentioned trial is to confirm the technical feasibility of interactive TV service utilizing the existing telephone network. The technical knowledge on system integration and networking accumulated during the trial period is the knowledge essential for realization of the VDT service, which should continue to be developed for some time to come. Especially, it was resolved that the two most urgent tasks to be completed to facilitate commercialization of the service are solving the remaining technical problems uncovered during the test trial and securing a wide range of video programs. The lessons KT has learned to date as a result of the test trial can be summarized as follows.

6.1 RESULT OF ANALYSIS ON TEST TRIAL

VDT has been judged to be a more convenient video service than the existing CATV service for it allows subscribers to view a video program selected via a menu using a remote controller within a second of request.

The following is a summary of the test subscribers' opinions expressed through their responses to questionnaires as it pertains to technical aspects related to the test service to date.

- Picture Quality: VCR-tape picture quality as demonstrated is somewhat lower than broadcast picture quality. Whereas improvement in the picture quality is requested for movies, MPEG I was expressed to be satisfactory for services such as travel and education, information.

- Programs: The 100 hours worth of video information stored in the video server is very limited in terms of the range of customer program selection, and most customers require improvement in the program offering and the program quality by replacing all programs about once a month.

- Circuit Connection Rate: The number of customers who can be served simultaneously is 30, which is adequate even under the busiest traffic condition; the actual usage experienced is lower than this and call connection does not pose any problem.

- Subscriber Menu (Graphic User Interface): Initial introductory screen and program menu are created based on text, and visual effect on the video service is only mild.

- Subscriber Loop Range: Although the range between the central office and the customer terminal on the existing telephone wire currently has to be less than 3.2Km, service can be extensively provided to most telephone customers because that the range can be improved to 4.5Km by improving the modem performance.

- Typical Examples of Problems:
  - Disabled calls due to ADSL outage
  - Video stream interruptions during viewing due to unstable system performance at the beginning of the test trial
  - Interference with broadcast TV signals due to the use of 110V/220V step transformers.

The test trial showed that the main areas needing immediate improvements include the design of program materials based on an accurate analysis of subscriber's video content desires, needs of professionals in the planning area, and a comprehensive infrastructure for Graphics User Interface(GUI) to help maximize visual effects on the most frequently encountered subscriber screens, i.e., initial screen, guide menu, and program menu.

6.2 SYSTEM INTEGRATION

Even though many international countries are striving to achieve the video on demand service, they are still at the level of core technology development and test trial. Since the necessary equipment has not been standardized yet, and there is no uniformity in equipment specifications or interconnection between equipment yet in any country in the world, whenever a system needs to be built, it has to be designed and manufactured on a customer's order basis.

As a case in point, the trend between the video server and the DET is to process storage, access and retrieve multimedia information using the client/server architecture. In contrast, world renowned video server vendors such as IBM, Microsoft, and DEC use their own unique connection protocols and video information presentation methods and operating systems. Due to these reasons, equipment manufactured by different companies cannot easily interoperate; even if they can be made interoperable, it can be done only after major modification of hardware/software, almost to the level of redesign and remanufacture.

In the case of multi-media networking, the general trend in full service networking is to replace the existing switching systems with ATM switches. However, at this point in time, effective investment in ATM switches is justified only in the application area of broadband data networks.

switches. However, at this point in time, effective investment in ATM switches is justified only in the application area of broadband data networks. It has been confirmed through this trial that processing high-speed video information and low-speed subscriber control signals in real time together is difficult for ATM switches.

6.3 NETWORK EVOLUTION STRATEGY

The existing telephone network offers the great advantage of speedy service provisioning by utilizing ADSL technology. However, since the existing technical does not offer picture quality comparable to that offered by CATV, the MPEGII technology has to be employed to achieve broadcast picture quality. Also, even though the upstream data rates from the DET to the video server required now amounts only to tens of Kbps, the existing telephone network has limitations because later hundreds of Kbps or several of Mbps of upstream data speeds will be required to offer real-time video games or video teleconferencing services. In order to overcome this limitation, mixed network of light fiber and coaxial cable, i.e., Hybrid Fiber Coaxial(HFC) architecture, is needed. Even if only VCR picture quality level of MPEGI class is offered in the case of the existing telephone cable, MPEGII level video transmission will be possible by the use of light fiber cable and the quality will be improved to that of broadcast video.

KT has also initiated development of Full Service Network (FSN) which can service VF,data, and video simultaneously by modifying experimental digital light-fiber system named Social Welfare Advanced Network (SWAN) which was developed to realize VOD service through a CATV network. When such a FSN is successfully developed, a multitude of multimedia services including VDT will become possible.

While the subscriber light cable access network which is based on the Fiber to The Home (FTTH) technology gets constructed as the broadband information network is being completed, VDT service will be offered first among different multimedia services.

7. CONCLUSION

Korea Telecom is now in a position to share the experience and related information we accumulated through this trial with other countries that are interested in it.

Cooperative relations could be worked out according to the unique interest and concern of each country. Strategic international cooperation based on mutual benefit and mutual respect will play a crucial role in realizing successful multimedia business in the Asia-Pacific countries.

Design and Implementation of an Enhanced Relational Database Management System for Telecommunication and Network Applications

Takashi Honishi, Nobuyuki Kobayashi, and Jinnosuke Nakamura

NTT Information and Communication Systems Laboratories
Yokosuka, Kanagawa, Japan

1. Abstract

RENA is a main memory resident relational database management system designed for special applications fields such as telecommunications, networks, and some plant-process control applications. In these special fields, in comparison to business or banking applications, the amount of data isn't so large and data handling is simple. However, the level of performance required for handling data is very high and the availability of non-stop processing against system maintenance, e.g., reconfiguring the database, or system failure is very important. Therefore, in these fields, database management systems should have a high level of performance and availability. RENA is an enhanced relational database management system that satisfies both of these requirements.

2. Introduction

Database management systems are now being used in special application fields such as telecommunications, network management and plant-process control. These applications, which we call real-time applications, require a database management system with superior performance (short response time, high throughput) compared to the database management systems used in business or banking applications. Although the amount of data in real-time applications is small (may be less than few gigabytes) and data handling is simple, the level of performance required for accessing the database is very high. In addition, the availability of non-stop processing against system maintenance, e.g., reconfiguring the database, or system failure is very important, because these real-time application services must be available continuously 24 hours a day, 365 days a year.

On the other hand, decreases in memory cost have made it possible to implement the main memory resident database management system can store a full database on the physical main memory. Because the data can be accessed directly without disk accesses (I/O operations) like in conventional disk-based database management system, the main memory resident database architecture is efficient for real-time applications requiring short response time and high throughput. Although a variety of main memory resident database management systems have been proposed ([1],[2]), none of them satisfy the requirement for both high performance and around-the-clock availability.

In this paper, we describe the design and implementation of a main memory resident database management system called RENA. RENA is an enhanced database management system that meets the above requirements and is applicable to the real-time applications in the telecommunications and network fields.

3. Requirements for a database management system in the Telecommunication and Network Field

The support of telecommunication services, such as 800 service and mobile and personal communications service in an Intelligent Network (IN) architecture, is an example of a real-time application. The IN's architecture is hierarchical and it can provide various advanced telecommunication services flexibly, timely, and inexpensively. Recently, the IN architecture has received world-wide attention and it has begun to be introduced by some telecommunication companies ([3],[4],[5]). The IN architecture of NTT(Nippon Telegraph and Telephone Public Corporation) divides the network into a transport layer and an intelligent layer (Fig.1) ([6],[7]). The transport layer consists of switching and transmission layers. The intelligent layer includes functions for network management, service management and service system modification needed when a service is added because only a part of the intelligent layer has to be changed. This layer manages and processes various data to support telecommunication services. For example, for 800 service, the intelligent layer knows the relation between a logical telephone number and a physical one and can translate the logical one into the physical one in a very short time between the time the caller dials the number and the time the phone rings at the other end. In the case of mobile and personal telecommunication service, the intelligent layer registers the position of the terminal and updates it when the terminal moves from one area to another. As the number of customers, the amount of data will increase. As the number of service increases, the data structures will be added or changed.

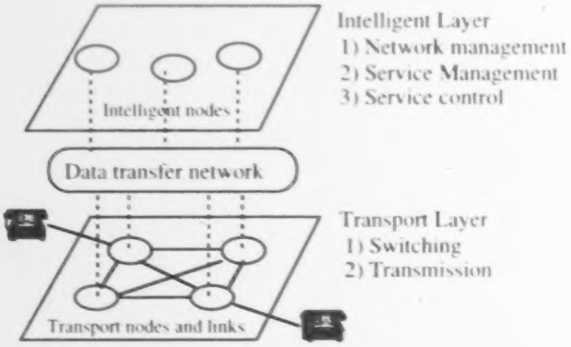


Fig.1. The architecture of IN

As mentioned above, it has become necessary to use an intelligent layer to manage various data flexibly. The situation is the same as when business applications had to handle various data and thus became complicated. By introducing database management systems into business applications, the cost of developing systems was reduced and flexibility improved because the high degree of independence achieved between the data and the processes. We believe that a good approach is to use database management system in such systems, especially the intelligent layer.

The requirements for database management systems in real-time applications of IN systems are different from those of conventional database management systems for business applications (Fig. 2). These requirements can be summarized as follows.

Performance: Response time must be reduced to less than 1/10, and throughput has to be increased more than 10 times.

Availability: Because real-time applications must run continuously, there should be no stopping for database maintenance, e.g., reconfiguring database, or system failure, e.g., hardware or software errors. In business applications, the database management system can allow service to be interrupted for a few hours for database maintenance. In addition, a few minutes is given to recover database from system failure.

Database size: The amount of data in the real-time applications is less than a few gigabytes. On the other hand, the amount of data in business applications is less than a few hundred gigabytes.

Data Access: Data handling is simple. The main pattern of accesses to the database is a single record access from one table. However, there are hot spots, which means that a lot of retrieving and updating is always concentrated on the same table.

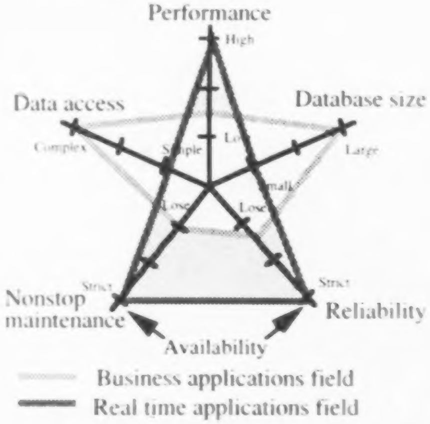


Fig.2. The requirements of database management system for real-time applications in IN

RENA, as will be shown below, can satisfy all of the above requirements for real-time applications.

4. The Design and Implementation of RENA

RENA is a main memory resident database management system. The system architecture is illustrated in Fig.3. The technical issues involved in building a high-performance main memory resident database management system are as follows: (1) the memory database architecture, (2) accessing the memory database, (3) developing a back-up and recovery method for the memory database, and (4) query processing. An additional issue concerning high availability is (5) creating a non-stop database maintenance mechanism for continuous service.

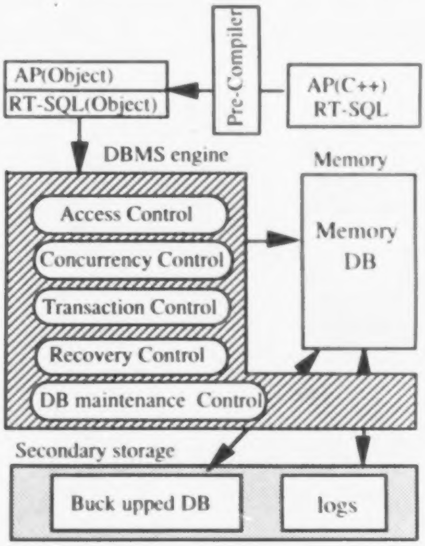


Fig. 3. The RENA architecture

4.1 Memory database architecture

The database is divided into two layers: a database on the main memory and a back-up database on a secondary storage such as a disk (Fig. 3). The data structure on the main memory is tuned to fit the memory access method, e.g., pointer access. The back-up database is a copy of the entire memory resident database and the copying is done periodically. A transaction log showing how the data changed before and after updating the database is stored on the secondary storage at the end of each transaction. The improvement in performance with this architecture comes from the following factors. First, I/O operations for database accesses are eliminated, so database access speed is greatly improved. A high I/O can seriously reduce database access performance, and decreasing I/O cost is a key issue in conventional disk-based database architecture. Second, it is not necessary to have I/O buffer management processing when data is accessed. In disk-based database architectures, it is necessary to check if the target data is in memory even if the data is cashed on memory. Third, we can design a simple data storage structure on memory, because data can be laid out on a continuous memory space without using a disk I/O block structure. Moreover, this structure is suitable for pointer access. This architecture is very suitable for the decreased database size and data accessing cost.

4.2 Accessing the memory database

A: Index Access

The index speeds up access to get the target data and it is usually used in relational database management system. In a main memory resident database management system, index access is efficient to get the target tuples quickly, and various index structures have been proposed and evaluated [8]. RENA is designed so that all tuples are always accessed by using an index, so the index structure is important for high performance. Our analysis of IN's real-time application showed that the database access queries requiring the highest speed are exact-match queries: this means the query has equal conditions and the hit tuple is one. Therefore, we selected a type of extendible hash tree structure [9] and modified it to give it an adequate memory structure. The merits of our index structure are lower searching and updating costs, a smaller index area, and better concurrency between searching and updating.

B: Concurrency Control

Database management systems have a concurrency control mechanism to guarantee the correctness of the database when it is concurrently accessed by several users. The two-phase locking algorithm [10] is usually used as the concurrency control mechanism. However, strict lock-based concurrency control reduces database accessing performance because of the high cost of conflict detection and the blocking of transactions. For example, when a transaction accesses tuples, the database management system must check each tuple to see if those tuples are being used in another transaction. This check is costly and decreases response time. Moreover, when there is a conflict, the transaction is put on hold until it is resolved. This decreases throughput. Because database access is so fast in the main memory resident database and the transaction time so short in real-time applications, we designed the concurrency control as follows.

The concurrency control is based on a two-phase lock algorithm. To reduce the rate of conflict, the lock granularity must be confined to individual tuples. When a conflict occurs, the transaction is always determined as an error without waiting for another transaction. The reason for this protocol is that the re-start transaction cost will be lower than the strict concurrency control cost.

Our tuned-up concurrency control mechanism reduces the total cost of query processing and helps boost performance.

4.3 Back-up and Recovery

In a main memory resident database, recovery involves two procedures: (a) a back-up procedure that keeps the buck-up database of the memory database and transaction logs in secondary storage continuing database accessing in usual transactions, and (b) a recovery procedure for recovering the memory database from the backed-up database and transaction logs when some failures occur. The back-up procedure requires a lot of execution time and large block I/O operations to keep the back-up database and I/O operations to keep the transaction logs in the secondary storage.

Because the back-up procedure requires I/O operations and much execution time, it must be designed carefully so it does not interfere with usual transactions. We use a Fuzzy Check Point mechanism ([11],[12]) as a back-up mechanism because it does not interfere with usual transaction processing [13]. The Fuzzy Check Point mechanism reads the data of the memory database without locking them and writes them into the Fuzzy Check Point files. The back-up database in these files is dirty, but it can be cleaned by using transaction logs when the recovery procedure is done.

We have also made some improvements in how the transaction logs are kept [13]. The granularity of a log is a column and all logs are packed into a log buffer. At the end of a transaction, all logs in the log buffer are stored into secondary storage with one I/O operation. This decreases the size of the logs and the number of I/O operations.

4.4 Query processing

We have defined the Real-Time SQL specification and the pre-compiled query processing method to achieve high-speed query processing.

A: Real-Time SQL specification

As mentioned above, according to our analyses of real-time applications of IN services, most accesses to database are very simple. This means real-time applications do not require complex queries such as a join operation, sub query operation, or sort operation in SQL. Therefore, we use subset queries and limit their functions from SQL. The subset of SQL is called Real-Time SQL. The Real-Time SQL has some restrictions: data accessing queries such as select, update, and delete, should be represented as exactly-matching queries which always have an equal condition with the primary key of the table. In addition, each table should be designed so that it has at least one set of columns constructing the primary key and it has at least one index to the primary key. The Real-Time SQL decreases the cost of query processing because it eliminates query execution control such as the management of the cursors used to return multi-result tuples to applications one by one.

B: Query processing method

RENA supports embedded Real-Time SQL/C++. Programmers make applications according to Real-Time SQLs in host programming language C++. The query processing method for embedded Real-Time SQL/C++ can be summarized as follows. First, using RENA's pre-compiler, Real-Time SQLs embedded in host language C++ source codes are extracted and translated to C++ source codes. At this time optimization of Real-Time SQLs, such as finding optimal access path, is done. Next, the translated Real-Time SQL C++ source codes are compiled by the C++ compiler into Real-Time SQL object codes. Third, they are linked to the application object codes. At the execution of applications including RT-SQLs, RENA is called directly from applications object code. We call this query processing method the Compiled SQL. This method decreases the cost of query processing because interpretive execution control, such as query optimization, is not required and the interface overhead between the application and database management system is eliminated.

4.5 Non-stop Database Maintenance Mechanism

Usually, a relational database management system has database maintenance functions for database reconfiguration, e.g., change of the database schema, and database reorganization, e.g. database garbage collection. These functions are required for real-time applications for system flexibility. Because the real-time application services are continued 24 hours a day year round, maintenance must be done without stopping the services. RENA has a non-stop database maintenance mechanism [13]. It is outlined below using the example of column addition to a table, which is a database reconfiguration process.

The unit of database maintenance is a table. In the case of column addition, first the target table is copied on a free memory area. During this time, usual transaction access to the original table is allowed and is not interrupted by the copying process. Next the new column is added to the copied table and the differential data between the new table and the original are reflected in the new table by the logs of the original table. At the end of the process, the original table is switched to the new table and the data accesses are changed from the original table to the new table. Both processes are done synchronously.

5. Performance Test

To confirm the performance of RENA, we executed RENA in a UNIX environment and examined its performance against some commercial database management systems. The performance test environment is shown in Fig. 4. We used 3 kind of commercial relational database management systems for the comparison. They are disk-base database management systems and popular in the business applications fields. The conditions of our examination are shown in Fig. 5. We used the TPC-B model [14], which is one of the standard database management system benchmark models. The scale of the database size is type 2 and this does not follow TPC-B regulations because of the memory limitations in our hardware environment. Only one process was done because we wanted to get only basic performance data. RENA is a type of main memory resident database management system and it does not require I/O operations during transaction execution. On the other hand, the commercial database management systems are disk based ones and do require them. To make the performance test conditions as close as possible, we let the commercial database management systems warm up before starting the performance measurements. We also defined indexes on the primary keys and tuned up the system generation parameters as much as possible.

WS	Sun sparc-4/IX(IPX)
Memory	64 MB
Disk	520 MB+ 2*4 GB
OS	Sun OS 4.1.3

Fig.4. The environments of performance tests

Conditions	Values
Benchmark model	TPC-B
Scale of DB size	2
Number of processes	1
Warming up time	150 Seconds
Examined time	960 Second

Fig.5. The condition of performance tests

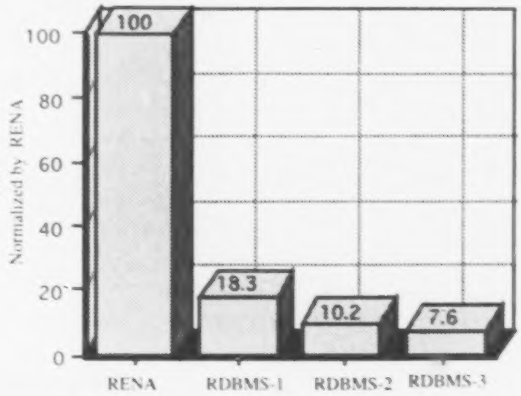


Fig.6. The results of performance test

We measured Transactions Per Second (TPS) in each database management system. The results are shown in Fig. 6. Each value is normalized with the RENA TPS at 100. The performance tests are not strict evaluations because the test environments were not always optimal for the commercial database management systems, but the results suggest that RENA will be able to achieve high performance compared with current commercial database management systems and that it will be suitable for real-time applications.

6. Summary and Future Work

We described the design and implementation of RENA, a database management system that has the high performance and high availability needed for real-time applications for the telecommunications and network fields. RENA achieves high performance with a memory database architecture, a method for accessing the memory database, a back-up and recovery method for the memory database, and the low-cost query processing. Moreover, RENA has a non-stop database maintenance mechanism for high availability. Our conclusion is that RENA is an enhanced relational database management system that provides both high performance and high availability and it is useful for real-time applications where the handling of various data and flexibility are required.

We will evaluate the performance of RENA with some real-time applications in the telecommunication and network fields. We will also design and implement a database fault tolerant mechanism that is based on a redundant database architecture to prevent system failure.

References

[1] H. Garcia-Molina, K.Salem, "Main Memory Database Systems: An Overview," *IEEE Transactions on Knowledge and Data Engineering*, Vol.4, Dec. 1992, pp. 507-516.

[2] H. V. Jagasish, D. Lieuwen, R. Rastogi, and A. Silberschatz, "Dali: High Performance Main Memory Storage Manager," in *Proceeding of 20th VLDB Conference*, 1994, pp. 48-59.

[3] J. J. Garrahan, P. A. Russo, K. Kitami, and R. Kung, "Intelligent Network Overview," *IEEE Communication Magazine*, Mar. 1993, pp. 30-36.

[4] E. Cancer, R. McCann, and M. Aboudharam, "IN Rollout in Europe," *IEEE Communication Magazine*, Mar. 1993, pp. 38-47.

[5] P. A. Russo, K. Bechard, E. Brooks, R.L. Corn, R. Gove, W.L. Honig, and J. Young, "IN Rollout in the United States," *IEEE Communication Magazine*, Mar. 1993, pp. 56-63.

[6] H. Simizu, M. Oka, R. Takaichi, "Development of Intelligent Network and Deployment of Advanced Services," in *Proceedings of Pacific Telecommunications Council Fourteenth Annual Conference*, Jan. 1992, pp. 219-222.

[7] S. Suzuki, "IN Rollout in Japan," *IEEE Communication Magazine*, Mar. 1993, pp. 48-55.

[8] T. J. Lehman, M. J. Carey, "A study of Index Structure for Main Memory Database Management Systems," in *Proceeding of 12th VLDB Conference*, Aug. 1986, pp. 294-303.

[9] E. L. Otto, "Linearizing the Directory Growth in Order Preserving Extendible Hashing," in *Proceeding of 4th International Conference Data Engineering*, Feb. 1988.

[10] Bernstein, P., V. Hadzilacos, and N. Goodman, "*Concurrency Control and Recovery in Database Systems*," Addison-Wesley, 1987.

[11] D. J. Rosenkrantz, "Dynamic Database Dumping," In *Procs. of the ACM SIGMOD Conf. on Management of Data*, 1978, pp. 3-8.

[12] R. B. Hangmann, "A crash recovery scheme for memory-resident database system," *IEEE Trans. Computer.*, vol. C-35, Sept. 1986, pp. 839-842.

[13] N. Kobayashi, T. Honishi, Y. Umemoto, "A DB Maintenance and Backup Method for Main Memory Resident Databases for Telecommunication and Network services," *The 10th International Conference on Information Networking*, Jan. 1996.

[14] J. Gray, editor. "*The Benchmark Handbook for Database and Transaction Processing Systems*.,, "Morgan Kaufmann, 2 edition, 1993.

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NOTES:

Adding Value to Broadband Services

Reg Russ
General Manager, New Media
Television New Zealand Limited
Auckland, New Zealand

1. ABSTRACT

Players who wish to extend their narrowband businesses in telephony, print publishing and on-line services into broadband services provide much of the driving force for the rapid advances in technological applications. But what of the companies already in the broadband communications business? Will they be sidelined or swamped?

This paper considers the options and opportunities for broadcasters. How they will add value to not only survive but prosper in an era of increasing broadband competition and an age of bewildering consumer choice.

2. INTRODUCTION

PTC '96 marks a watershed in the first decade of the information era. For the first half of the '90s we've been bombarded, confused and, dare I say it, misled as we've sought to grapple with the implications of the convergence of established industries - telecommunications, entertainment, computing and print publishing.

Now promises are becoming reality. Technology has caught up with expectations. We're riding the crest of the first of three waves - the widespread use of non-linear interactivity via databases, CD-ROMs and narrowband on-line services.

The second wave now forming will be the widespread use of broadband distribution channels providing user-driven control of information and entertainment streams using narrowband return path mechanisms.

The third wave will have to wait for far better business cases than we currently have. Switched broadband bi-directional services will be expensive for many years yet.

What we learn on the present wave will be vital as we ride the next.

In the process of moving from the old story (mass dissemination of information and entertainment) to the new story (all of the information and all of the entertainment being available all of the time at the user's discretion) changes are dominated by previously low grade narrowband services expanding to provide more and more channels and better quality channels to the interactive user-controlled environment. Many of the technology trials, and certainly many of the economic models, make the assumption that the present broadband operators will lose market share and, having peaked as a mature industry, gradually decline to provide just more niche services in the multi-channel future.

I want to explain why that need not be so.

3. THE BROADBAND INDUSTRY

Broadcasters around the world have been enjoying the hiatus of the technological delays and shortfalls which postponed, cancelled or abbreviated experimental pilots designed to prove that consumers want all the delivery pipes full, want to be involved in searching out their own mix of entertainment and information, and are prepared to pay the sometimes multiple costs of hardware, subscription and usage for the new services.

In some countries it is true that broadcast viewing is declining on a per-channel basis. In others the ratings are as high as ever, with little sign of change as the market fragments. In most countries total viewing hours are remaining constant and we've come to accept already that added channels will not force people to watch screens for a greater number of their discretionary hours.

Some might say that broadcasters have been conservative as they watch the mergers (and attempted mergers), acquisitions and alliances between converging industries. Broadcasters by nature are evolutionists and are determined not to be stampeded into any sort of a revolution just because the technology is available.

In our mature industry we've become quite good at what we do, our research is superb, the way we refine our products to match market demands can seldom be faulted. We are good at providing what most people want. If it's leisure you want you'll get it from us, we'll do the hard work at our end making it easy at yours.

We've certainly learned not to believe in the computer industry hype; we're only prepared to plan for and purchase deliverable reality and few of us are prepared to buy serial number one of any equipment for on, or off, air use.

In our evolutionary way we are developing digital "islands" of equipment as the analogue variety comes up for replacement. Our long term planning is for a coherent, all-digital infrastructure creating, enhancing, packaging/ repackaging and distributing high quality programme material in ever more efficient ways.

Of course this word "digital" is a euphemism for the dirtier word "computerised". We enter the world of the computer with a great deal of concern. There's plenty of evidence to show that computer hardware and software vendors have grossly underestimated the quantities of data we collect, manipulate and distribute in the broadcasting process. There's evidence too to suggest that the "supply side push" from computer vendors has engendered incompatibilities which might work in "islands" but not in the broader environment.

At this mid-decade, however, costs of hardware and software are dropping, standards are becoming established, broadcast quality from generic open computer systems is possible, compression standards have arrived and affordable bulk storage is the enabler of completely new operational processes.

The most important form of convergence for us is that between the broadcasting, computing and print publishing industries, this is bringing fundamental changes to the ways we produce, package and distribute our products. Broadcasters have much to learn from the print industry which is, by and large, at least surviving if not prospering, as a result of the coherent digital systems it has embraced.

Of course we realise the awesome power of our telecommunications colleagues and we know we should be factoring them into our convergence plans, but their cultures seem very different to ours. In the deregulated communications environment of New Zealand we're proving that project-based alliances in which our Telco colleagues focus on distribution and customer service while we focus on content and interfaces are the sensible form of industry convergence.

4. BROADBAND COMPETITION

Alongside our traditional broadcasting services we realise the viewer at home, school or work will soon have choices in the form of:

- direct satellite television
- cable services of all types - gradually including interactive services
- wireless services - also with some interactivity
- on-line networks, databases, bulletin boards
- CD-ROMs
- videoconferencing/videophones??

and in more public areas we acknowledge that there will be a widespread use of kiosks - more public ways of providing universal services.

In developed countries these new services seem certain to have increasing appeal to generations who have never known life without television, and for whom the screens on the television sets and computers are essential for communication in an increasingly complex world. In developing countries we are seeing a broad range of basic and advanced services developing more or less simultaneously, telescoping the evolutionary process to the superhighways of the third wave.

5. CHALLENGES

The challenge for broadcasters will be firstly to hold viewer loyalty on existing channels in the face of competition. We can then convince funding agencies and advertisers that we are doing a worthwhile job and that they needn't spend their money on the new niche competitors of the information age.

Secondly, digital techniques are the enablers of profitable new enterprises alongside our core business. New revenue from CD-ROMs, databases, on-line services will supplement our core revenue streams.

A third agenda - perhaps not such a new one - is to use new technologies to continuously reduce our production packaging and distribution costs to let us pend more on enhancing our product and keep ahead in the race for survival and prosperity in the information era.

5.1 ADDING VALUE FOR VIEWER LOYALTY

It's already evident that the computing screens of the computers and on-line services are especially attractive to younger viewers. Computers provide vivid graphics, complex interactive games, superb reference and educational material, and the on-line services such a wealth of easily accessible information, that broadcasters face the risk of losing younger audiences. It follows that to compete successfully we must provide similar levels of quality and stimulation. Increasingly those viewers will want to take more control of the viewing options so "interactive" response options and real-time viewer manipulation of programme elements are highly desirable.

We've made a start by producing stimulating interesting graphics from remote data to let our sports and business viewers see simple explanations of complex information.

Interaction with commercials and programme elements via the 0800 (broadcasters pay) and 0900 (viewers pay) is now well developed in many countries. Touchtone 'phone control of on-air commercials is another example of how we're entertaining and rewarding viewers whilst delivering astonishing sales results to advertisers.

We've also made a start with some interactive programming. Our children's programmes are enhanced with games and educational programmes which use touchtone telephone interactivity for the lucky viewer or viewers (up to 4) to interact with the programme content. This translates directly into programme ratings for our audience of the new millenium.

5.2 ADDING VALUE TO OBTAIN NEW REVENUE

5.2.1 Desktop Television

From our digital databases we can source material for our on-air programmes to provide specialised information for niche audiences - geographical, cultural, professional niches - and market niches such as educational, business or community. The new media tools, many of which come straight from print publishing, can help us provide such material at a fraction of the cost of traditional broadcasting programmes.

The "tricks" of new media electronic publishing such as reduced screen sizes, lower frame rates, reduced horizontal resolution, together with presentation techniques which accommodate the restricted data transfer rates currently possible, are all being applied to enable standard generic computers to produce acceptable broadcast-like products. The analogy I like to use is that we can produce cable television quality at newspaper prices.

5.2.2 CD-ROMs

Of course those same publishing techniques are precisely what CD-ROM publishing is all about and why CD-ROMs are one of the marketing revolutions of our age. Although no more than an enhancement of familiar technologies, they are achieving spectacular growth figures because of their familiarity. With a digital video standard soon to be available broadcasters can expect to realise their normal full-screen, full-motion, quality levels as this popular platform evolves.

The economics of CD-ROM publishing are such that international sales are often needed to justify quality development - especially where original material has to be prepared. Budgets upwards of US$300,000 are common and high quality is absolutely essential if good sales are required. For broadcasters who have digital graphics and post-production equipment already available, domestic or specialised markets will often give good returns. The usual method is by reversioning material or adding CD-ROM authoring to linear programme production to achieve much lower costs - perhaps below US$30,000.

The market niches for broadcasters seem to be in reference and education - fields where steady long-term revenues can be anticipated without the short "boom" of consumer titles.

Broadcasters can use unsold commercial time to direct market these products. Good margins mean low break-even volumes are possible.

CD-ROMs are not like books. CD plants now accommodate small pressing runs, short delivery periods. We can order supplies and expect delivery in under ten days - labelled, boxed and shrink-wrapped.

5.2.3 On-Line Services

Following closely behind the exponential market growth of CD-ROMs are the on-line services. They cope with text and some modest graphics already and as network speeds increase the possibilities of obtaining low quality video are evident. Some broadcasters are providing support for regular programming, especially educational, and information material on Internet and Compuserve, but the economics are still doubtful and the services can be no more than experimental. No-one knows what returns are possible, or what will be possible, from providing our content "on-line". In TVNZ we know from our early experiments that the risks of hackers working back into our systems are so high that such databases must be isolated from the in-house networks for fear of illegal tampering and malicious manipulation of our data. This is an area where we will adopt a cautious approach in spite of the talk of 100 million users on this lane of the "superhighway".

Those of us broadcasters who depend on advertising revenue for our survival will have to pay considerable attention to the implications of on-line services. We very much want them to be complementary, not competitive, products.

5.2.4 Kiosks

Public installations designed to make information available to many people - are attractive too. We can load these computers with data from our broadcast signals - even if they're mobile - anywhere within our coverage area. The fixed ones might function as local on-line nodes for domestic and commercial information. Our strengths are that we can distribute vast amounts of information at very little cost and we can make access appealing and useful. The worlds of computing and printing are supplying the software for us to develop these, and other, external applications. We can supply the content, the communication skills, flair, style.

5.2.5 Copyright

As broadcasters we are experts at handling the copyright and intellectual property issues associated with such reversioning, and in this respect we have a substantial competitive advantage over newcomers trying to take advantage of the low start-up costs the new media technologies provide.

6. ADDING VALUE BY REDUCING OVERHEADS AND PRODUCTION COSTS

We are turning inwards as well, examining our traditions, processes, starting again to find new smart ways of using multimedia tools in the making of programmes, scheduling, originating. Indeed the whole process from conception or purchasing through planning, preparation, shooting, editing, promotion, publicity, facilities management and on-air origination is ripe for modernisation. Productivity gains will eventually result - and, I believe, on a very significant scale.

Non-linear digital editing of video and audio is one application which is here to stay. Standard computer workstations with applications defined by software to the needs of the day look attractive too, especially when networked for team operation.

7. ADDING VALUE THROUGH ORGANISATIONAL CHANGE

An often overlooked ingredient in the evolutionary process is how we structure for rapid change, preparing our staff and encouraging them to contribute to the process.

Our answer has been to develop a learning culture. We encourage our staff to contribute to research and development, we take the future to them. The result is a continual process of creating awareness, seeking applications, trial and development.

The message is "involve our staff in the changes new media technologies promote".

8. ADDING VALUE BY DEVELOPING COHERENT SYSTEMS

And here's my personal vision. It's of a gradual, sensible evolution, to a digital future which is entirely standardised. It will not only result in significant productivity improvements to the traditional core business of broadcasting, but be immediately useful for any, or all, of the added value products.

We're through the era of incompatible proprietary hardware and software. We're heading for a future of:
- standardisation,
- interchangeable units,
- interchangeable services.

We're working towards networks and databases which talk to each other, communicate without degradation and allow us to focus on what we do best. To do it better, to do new things to not only survive, but to prosper in a future based on choice, consumer control, the era in which individuals will take responsibility for what they see.

9. GENERAL

The trends will be for mass appeal broadcast products to be complemented by narrowcast ones derived from the same material. Our challenge is to apply new technologies to distribute more and more content from which our customers can select. The evolution will be in the user's ability to choose - select, one way or another, what suits them.

As broadcasters we'll be paid when our content or service is used (computers are good at that). Our viewers will get the content, technical quality and delivery options that they're prepared to pay for.

The successful broadcaster of the future will develop quality alliances with convergence partners in the new media world. The resulting ventures will use new media technologies to add value to broadband content and diversify into new products and new markets. Clever broadcasters are installing coherent infrastructures to facilitate this while they reap the benefits of production economies of the digital systems.

Successful broadcasters will also prove that it's not technology which really matters. It's the customers who matter, their wants, their needs, how they manage the flood of options and, above all, what they will pay for all that choice. The content-rich broadcasters and their rights to exploit their content will give them the edge in the increasingly competitive broadband field.

10. CONCLUSIONS

Broadcasters will add value to their traditional broadband products to:
- retain existing viewers in the face of competition
- earn new revenue streams from existing content
- substantially reduce production costs by introducing coherent new technologies.

For this reason broadcasters are set to not only survive but prosper in the rapidly developing information era.

DIGITAL TECHNOLOGY FOR PROGRAM CONTRIBUTION AND DISTRIBUTION IN ABC RADIO

Peter N. Kepreotes
Broadcast Communications Development Manager

Australian Broadcasting Corporation
Sydney, Australia

ABSTRACT

ABC Radio has redesigned its arrangements for the contribution and distribution of program material and is now utilising an all-digital system, known as the Delta System. It is a three layered system comprising satellite, terrestrial and dial-up ISDN facilities and uses ISO (International Standards Organisation) /MPEG (Moving Picture Experts Group) Layer II digital audio compression so as to reduce overall system transmission costs.

The integration of the three layers has been achieved through the development of appropriate switching and control facilities as well as several custom hardware and software systems. The new system is scalable to readily allow for changing operational requirements, new services and can be reconfigured as needs and funding change. The new system will also position ABC Radio for the likely introduction of digital sound broadcasting (DSB) in Australia towards the end of the decade.

WHAT IS THE DELTA SYSTEM ?

Refer to Figure 1 for a simplified diagram of the Delta System.

The Delta system is a three layered system comprising,

▲ **Satellite** - distribution only

(Refer to Figure 2: Satellite Layer Diagram)

▲ **Terrestrial** - contribution & distribution

(Refer to Figure 3: Terrestrial Layer Diagram)

▲ **Dial-up ISDN** - contribution & distribution

(Refer to Figure 4: Dial-up ISDN Layer Diagram)

(The term 'Delta' is taken from the Greek triangular-shaped letter 'Δ' signifying the three layers being the 'corner-stones' of the system)

All three layers are implemented in the digital domain, using the ISO/MPEG Layer II coding algorithm for the cost-effective and efficient transmission of audio throughout the system.

WHAT DOES THE NEW SYSTEM REPLACE ?

The radio interchange system that has been replaced used primarily satellite single channel per carrier (SCPC) analogue circuits. This system allowed program material to be contributed, assembled and distributed to and from it's 8 Capital city and 22 Regional studio sites around Australia. However, it was based on old technology, was expensive to operate and had a number of other limitations. The Delta System provides many improvements over the previous system, including significantly reduced operating costs, improved audio quality, increased network coverage, increased flexibility, backup and redundancy.

WHY A DIGITAL SYSTEM ?

Digital systems have aroused much interest in the last few years because of the potential to significantly reduce transmission costs when compared with analogue systems as well as improving overall quality. Analogue systems usually require much larger bandwidths to transmit the equivalent audio, video or data material compared with a digital system.

Compression techniques have aroused considerable interest over the last few years with the emergence of the so-called '*super-Highway*'. This new highway will allow digitised video, audio, voice and data information to be sent over carrier's emerging digital networks. From the carrier's point of view the superhighway might be better termed the 'super-*Tollway*' whilst from the user's perspective they would like it to be the 'super-*Freeway*'.

However, reality dictates that digital capacity costs increase with increasing bit-rate. Hence the interest in data reduction or compression techniques is to minimise the amount of digital capacity utilised from a carrier.

Although much momentum has been gained in recent times concerning advances in video compression, audio compression has been more advanced in that the MPEG coding algorithm has made its way into manufacturer's codec equipment and has been operational for some time now.

In the case of audio, much lower bit rates than for video are required in order to successfully transmit and recover a compressed signal.

THE BENEFITS - WHAT WILL IT PROVIDE ?

1. The new three layered design is a complete replacement for the previous system, being more flexible, cost-effective and makes use of state-of-the-art technology so as to take advantage of developments in digital audio transmission and MPEG compression.

2. Considerable reductions in operating costs are expected from the date of implementation of 31st August 1994.

3. The Delta System has a number of strategic benefits including;

☞ *Improved audio quality and control facilities*

Able to distribute CD (compact disk) quality audio nationally with better methods of managing the network.

☞ *Cost-effective solution*

Able to increase the cost-effectiveness of transfer of program around the country.

☞ *ABC-owned facilities*

Not dependent on any single carrier, giving the ABC more control of its own operations and resources.

☞ *Flexibility to use any carrier or satellite system*

Not dependent on any one carrier and so can maximise benefit of competitive environment

☞ *Use of several technologies*

Allows for network diversity and therefore higher availability and continuity of service

☞ *Easy to reconfigure network (3 layers scalable in small increments)*

Inherent system design allows ABC Radio to readily increase or decrease infrastructure as needs and funding changes.

☞ *Increased access to network (over 50% increase in existing reach)*

The new design allows greater national coverage, particularly in Regional areas with access to dial-up ISDN.

☞ *User Pays*

Improved tracking of costs with dial-up ISDN and scheduling system. Design discourages unnecessary use of system.

☞ *Triple-J extension (Youth network - one of the six ABC Radio Networks)*

Design allows for the most cost-effective method of extending this Capital city network nationally throughout Regional Australia.

☞ *Radio Australia Distribution (ABC's International Short-Wave service)*

Will be delivered in a more cost-effective manner to transmitter sites through common satellite facilities with the Delta System.

DELTA SYSTEM DESIGN CONSIDERATIONS

There are a number of key areas comprising the Delta System, in addition to the three main layers, and all are briefly described as follows:

(1) Satellite

The satellite layer makes use of 10% of a 50W national beam footprint on the B1 domestic satellite system. To minimise the space segment requirements, efficient modulation techniques, which are suitable for satellite transmissions have been used. Quadrature phase shift keying (QPSK) modulation is used with 1/2 rate forward error correction (FEC), providing an efficient yet robust signal. A total of 15 digital audio channels are available.

MPEG compression is used on all digital channels which allows for either mono, dual mono, stereo or joint stereo operation and at various bit-rates from 56-384kbps per channel. All channels will operate at 256kbps with the exception of Radio Australia which only requires voice-grade or 64kbps per channel. In addition, auxiliary data and control information is available with each channel.

The digital satellite receivers are remotely configurable from the network management system located at the uplink hub sites. The receivers can be authorised, retuned and reconfigured on an individual or group basis as required. This can be carried out either on a dynamic or scheduled basis.

The ABC owned satellite facilities allows the ability to easily repoint this layer to other satellite systems which have coverage over Australia, without affecting the operation of the Delta System as a whole.

(2) Terrestrial

The terrestrial layer makes use of n x 64kbps digital terrestrial capacity which is provided by both general carriers. It is configured in a star configuration and duplex mode with Sydney as the hub point. Most Capital city studios 'nodes' are typically provided with a 640kbps duplex 'pipe' which is partitioned as 128kbps for high quality mono and 256kbps for high quality stereo program material.

Refer to *Figure 3* for the overall diagram of the terrestrial layer.

MPEG digital audio codecs are provided at each node point to encode/decode the audio into suitable compressed bit streams for transmission. The decoders automatically track the configuration of the encoders so that a network reconfiguration can easily be carried out. The encoders/decoders are also download-software-upgradable to readily allow for enhancements of the MPEG algorithm or the codec functionality.

In the evaluation phase of the Delta System, extensive network trials were conducted with the codecs where multi-pass tests and measurements were carried out. This was to ensure that satisfactory audio performance could be achieved for program interchange applications, where it is likely that the same encoded program material would repeatedly pass through the Delta System before final distribution.

The terrestrial capacity can be readily reconfigured to suit the changing ABC requirements by the incremental addition or deletion of capacity in 64kbps steps. The substantial costs of the terrestrial layer are in the establishment of each node point in the star configuration. Any incremental changes in the bit-rate for any Capital city pipe have only a corresponding incremental cost. This also allows for the possibility of providing voice and data services to these nodes, utilising the same pipes and thus providing further economies of scale.

A 2Mbps trunk connecting Sydney and Melbourne serves as a program audio trunk as well as a diversity route for the satellite uplinks. A 2Mbps multiplexer system breaks out the trunk into appropriate capacity for the program audio.

(3) Dial-up ISDN

The ISDN (Integrated Services Digital Network) rollout in Australia is now in an advanced stage of development. ABC Radio has considerable experience in using ISDN for audio applications since its introduction in 1988.

The carrier ISDN network reliability has matured to the point where we are currently able to provide interstate hourly news bulletins, two-ways from interstate and international locations, as well as afternoon outside broadcasts from sports stadiums.

The carrier is able to provide dial-up ISDN services to 36 of the 37 Regional studio sites which are part of the Delta System. These Regional sites are largely in diverse geographical

772

locations, as indicated in Figure 4. Dial-up ISDN provides tremendous flexibility that traditional dedicated point-to-point lines have not been able to provide in the past. Less co-ordination is required with master controls as the ISDN calls are made directly to the intended party on many occasions. Regional studios are now able to call any other site that is equipped with suitable ISDN equipment, whether it be domestic or international.

Refer to *Figure 4* for the overall diagram of the Dial-up ISDN layer.

The type of ISDN equipment deployed is functionally similar to the operation of a normal telephone, with a front panel touchpad and LCD display, 75 pre-programmed numbers and charging is on a per call basis. This is of particular importance as most users of the dial-up ISDN facilities in the Regionals are typically non-technical staff such as journalists. This system will lead to better tracking of costs and program traffic profile information.

Apart from being user-friendly, the ISDN equipment also has integrated within the same chassis the same type of codecs as those being used in the terrestrial layer. This results in a more compact, integrated and streamlined solution for the Delta System implementation.

Since Capital city studios have a heavier utilisation of ISDN than the Regional sites, they have been equipped with more comprehensive ISDN facilities including a user-friendly call management system. This system is software based and allows for multiple calls to be initiated, received and scheduled without undue effort and complexity being experienced by the master control (MCR) staff. This is so as not to detract staff from their other primary duties and responsibilities. The system also provides national monitoring and control of Capital city ISDN facilities.

For example, MCR Brisbane can initiate a call between MCR Perth and MCR Adelaide if required. Another example is that a call initiated by a Regional studio in Tasmania intended for Perth could be redirected to Melbourne and sent to Perth via the terrestrial layer if required.

Dial-up ISDN also serves as,

- overflow capacity for the terrestrial layer, if the terrestrial layer to any Capital city node is fully utilised at any particular time, due to peak loads

- back-up capacity for any satellite and terrestrial layer failures that may occur from time to time.

(4) Switching

A switcher is provided at the main hub in Sydney and serves as the focal point for all the switching and scheduling activities for all three layers of the Delta System. For numerous operational reasons, the switcher is currently configured to carry out its switching tasks in the analog domain although it is capable of switching in the digital domain as well.

As an enhancement to the Delta system, the switching activities will be progressively migrated to the digital domain to reduce the number of encode/decode stages for some program applications as well as conforming to the overall goal of creating a fully digital radio environment.

The scheduling of switching activities is being carried out through the provision of custom developed software which provides a user-friendly graphic user interface to an intelligent booking system. The booking system allows for the easy rescheduling, change or extension of bookings as required - features which are highly desirable in a program-making broadcasting environment.

(5) Custom Panels

A number of in-house developed custom panels have been built to meet specific needs of ABC Radio. For example an 'intercept panel' as it is known allows MCR operators to intercept incoming and outgoing ISDN calls to allow for co-ordination or trouble-shooting of ISDN calls.

The various custom panels, which are not described here, have been designed and developed by AlphaTec, which is the national technical services department for ABC Radio.

CONCLUSION

The Delta System makes use of an innovative design for the replacement and improvement of the old carrier-provided analog SCPC Radio Interchange system. The new system takes advantage of developments in ISO/MPEG Layer II audio compression to provide a cost-effective and flexible system which will meet ABC Radio's contribution and distribution requirements into the next millennium.

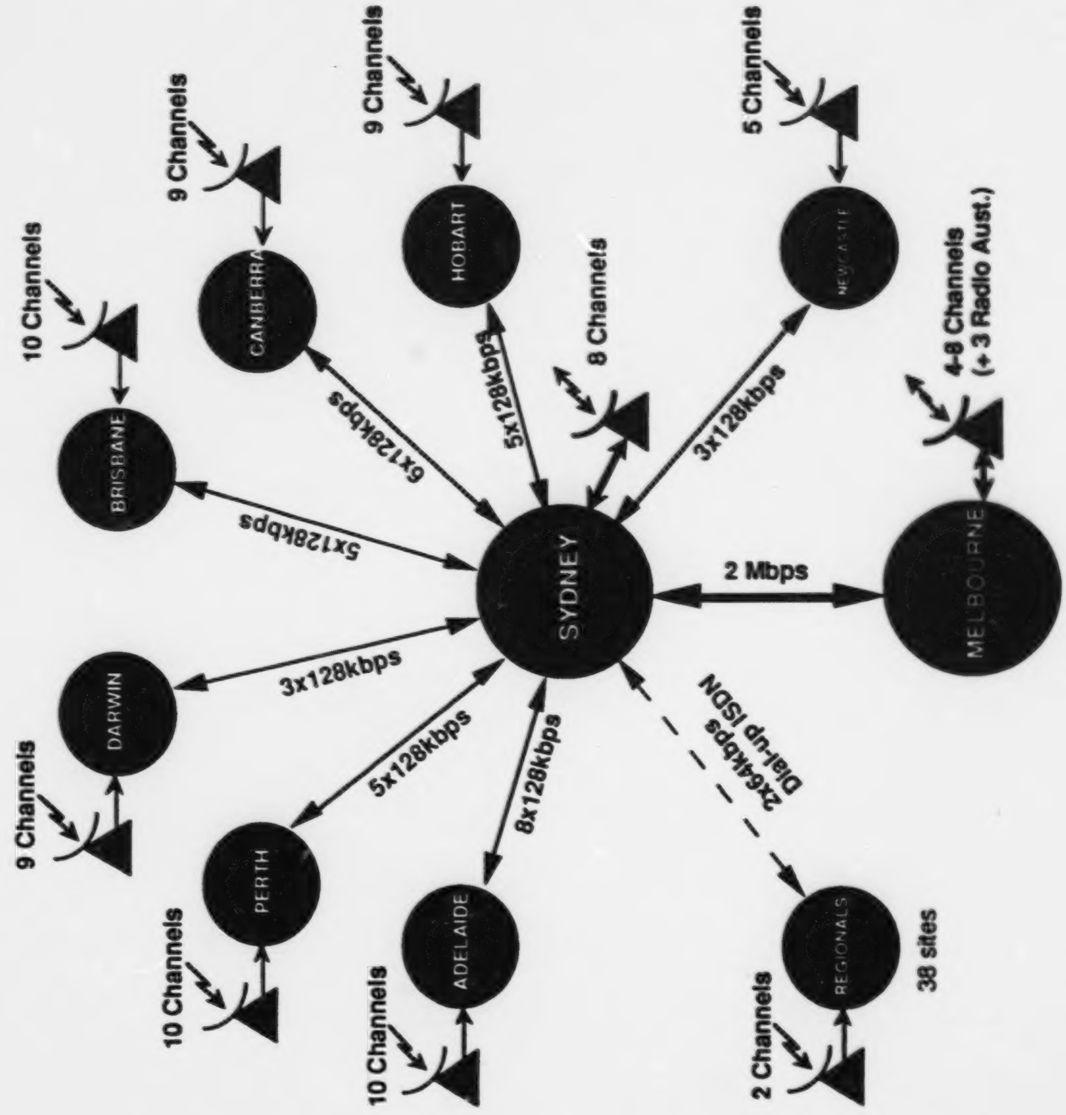
The inherent three layer design of the new system provides maximum flexibility, allowing each layer to be scaled appropriately as the needs of ABC Radio change with the changing environment.

The system provides a digital CD quality audio backbone which will position ABC Radio for the introduction of DSB and other services in Australia towards the end of the decade.

The introduction of the Delta System brings reduced operating costs whilst increasing facilities and positioning ABC Radio to obtain maximum advantage from the increasingly deregulated telecommunications environment in Australia.

* * *

Figure 1 - DELTA SYSTEM
SIMPLIFIED OVERALL BLOCK DIAGRAM


9 Channels
9 Channels
5 Channels
10 Channels
CANBERRA
HOBART
NEWCASTLE
8 Channels
4-8 Channels
(+ 3 Radio Aust.)
BRISBANE
6x128kbps
5x128kbps
3x128kbps
5x128kbps
SYDNEY
2 Mbps
MELBOURNE
DARWIN
3x128kbps
5x128kbps
8x128kbps
2x64kbps
Dial-up ISDN
9 Channels
PERTH
ADELAIDE
REGIONALS
38 sites
10 Channels
10 Channels
2 Channels

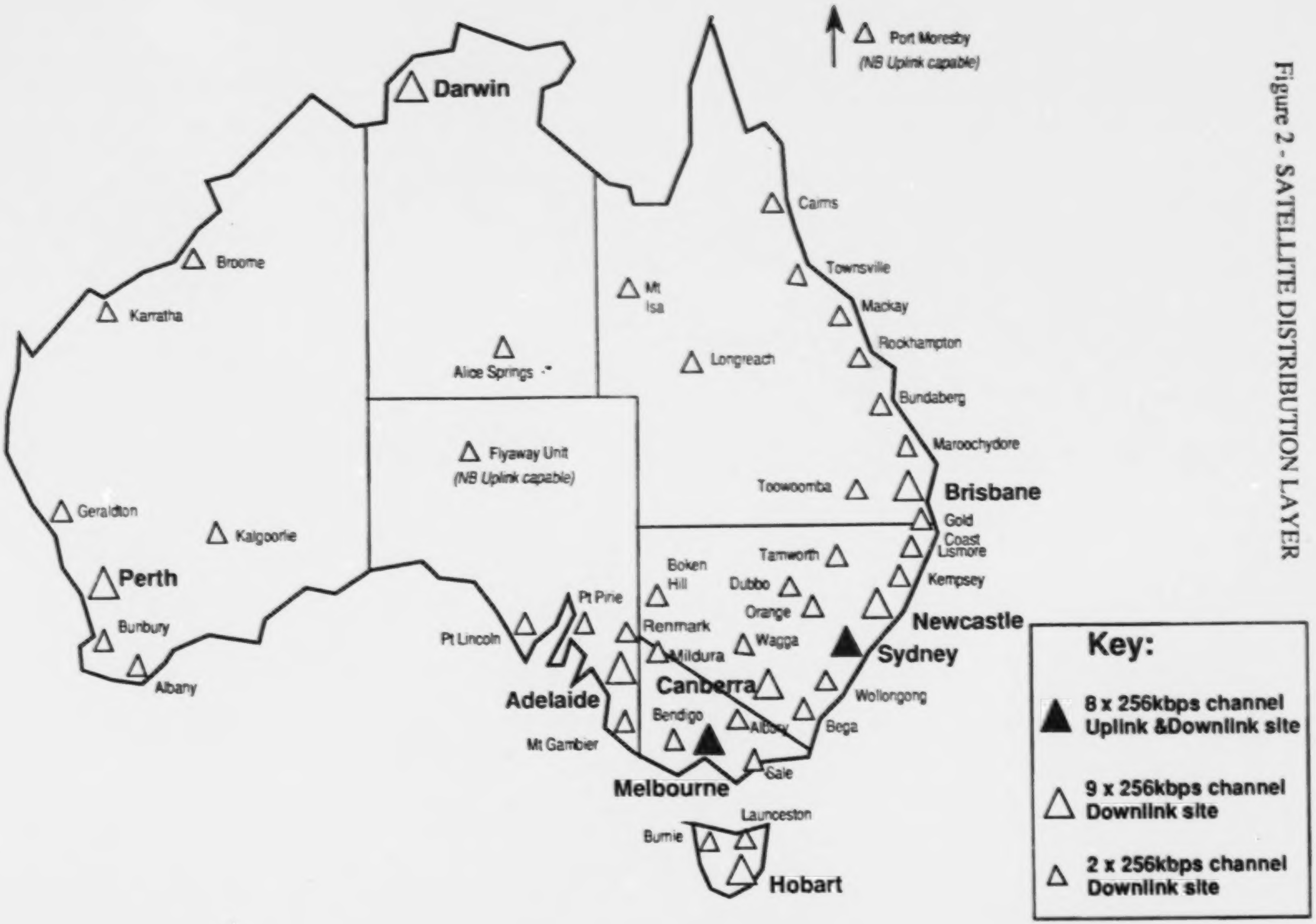

Port Moresby
(NB Uplink capable)
Darwin
Cairns
Townsville
Mackay
Rockhampton
Broome
Karratha
Mt
Isa
Longreach
Alice Springs
Bundaberg
Maroochydore
Flyaway Unit
(NB Uplink capable)
Toowoomba
Brisbane
Geraldton
Kalgoorlie
Gold
Coast
Lismore
Tamworth
Perth
Boken
Hill
Dubbo
Kempsey
Orange
Pt Pirie
Newcastle
Bunbury
Renmark
Wagga
Pt Lincoln
Mildura
Sydney
Albany
Canberra
Adelaide
Wollongong
Bendigo
Albury
Bega
Mt Gambier
Sale
Melbourne
Launceston
Burnie
Hobart
Key:
8 x 256kbps channel
Uplink &Downlink site
9 x 256kbps channel
Downlink site
2 x 256kbps channel
Downlink site

Figure 2 - SATELLITE DISTRIBUTION LAYER

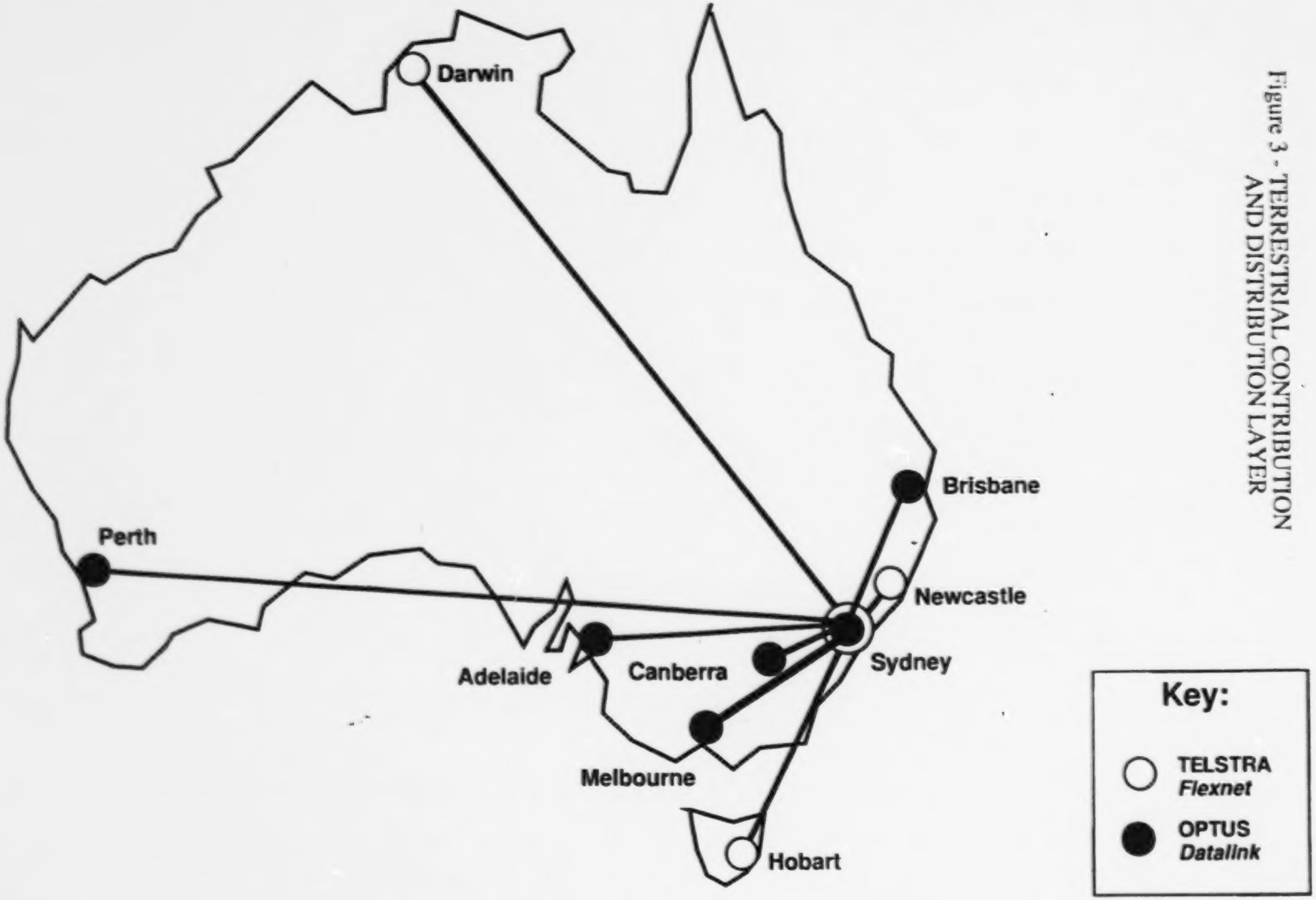

Darwin
Brisbane
Perth
Newcastle
Adelaide
Canberra
Sydney
Melbourne
Hobart
Key:
TELSTRA
Flexnet
OPTUS
Datalink

Figure 3 - TERRESTRIAL CONTRIBUTION AND DISTRIBUTION LAYER

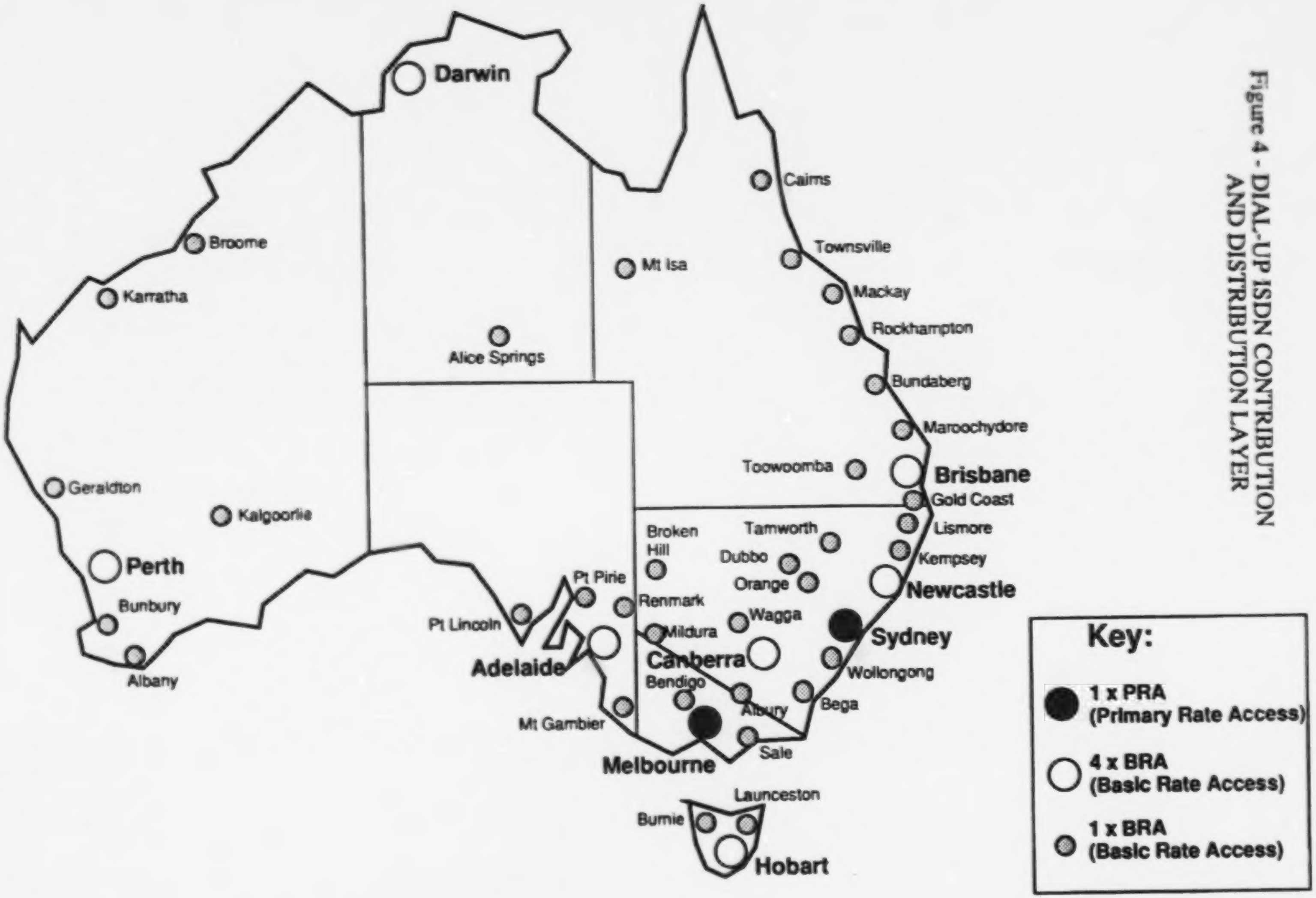

Darwin
Cairns
Broome
Karratha
Townsville
Mt Isa
Mackay
Rockhampton
Alice Springs
Bundaberg
Maroochydore
Toowoomba
Brisbane
Gold Coast
Geraldton
Kalgoorlie
Tamworth
Lismore
Broken Hill
Dubbo
Kempsey
Perth
Pt Pirie
Orange
Newcastle
Renmark
Bunbury
Wagga
Pt Lincoln
Mildura
Sydney
Canberra
Adelaide
Wollongong
Albany
Bendigo
Albury
Bega
Mt Gambier
Sale
Melbourne
Launceston
Burnie
Hobart
Key:
● 1 x PRA (Primary Rate Access)
○ 4 x BRA (Basic Rate Access)
◉ 1 x BRA (Basic Rate Access)

Figure 4 - DIAL-UP ISDN CONTRIBUTION AND DISTRIBUTION LAYER

High Quality Broadcast Television Transmission based upon International Standards

Yoshiaki Nozawa* Toru Shibuya**

* 2nd Transmission Division,
NEC Corporation, Kawasaki, Japan

** 1st Development Department of
NEC Miyagi, Ltd., Miyagi, Japan

ABSTRACT

Most of the recent video CODECs for broadcast-quality video signal transmission handle component video signals that conform to the studio-specification (ITU-R Rec. 601). ITU-R Recommendation 723 has regulated the encoding method for the transmission of high-quality video signals used for broadcast programs.

We have developed a video CODEC for broadcast-quality video signal transmission according to this standard. The video signal Encoder has employed newly-developed gate-arrays to realize this ITU-R Rec. 723 algorithm. It has also adopted our original technique, called "half-pixel accuracy estimation" for motion-vector estimation, resulting in a reduction of the size and low-power consumption of the equipment.

1. INTRODUCTION

We have already developed various video CODECs, including 45 Mbit/s video CODEC (product name: BROADCASTER 45) for the North American market that employed the HO-DPCM method [1], as well as 140 Mbit/s video CODEC with non-compression encoding (product name: BROADCASTER 140) for the CEPT market. These products are video CODECs which handle composite video signals. In transmitting these composite video signals with broadcast quality, the DPCM method is superior [2]. However, recently, component video signals have been used as the studio standard and the DCT method is becoming the major technique as the encoding method for component video signals.

Following the recent digitalization of broadcast networks, the ITU-R Recommendation 723 [3] has regulated the encoding method for component video signals based on the DCT method for transmitting high-quality video images for broadcast programs. The transmission rate was set to 34 through 45Mbit/s, which are equivalent to the third digital hierarchical level, DS3 rate employed in Europe and North America, respectively. On the other hand, the European Telecommunications Standards Institute (ETSI) has regulated the ETS 300 174 [4] standard for Europe, which has added requirements for the transmission-route side as well as for the equipment to the above-mentioned standard.

Since we have developed the CODEC (product name: BROADCASTER 34) for video signal transmission based on this standard, we describe in the following the features and configuration of this equipment as well as the technology which we have employed.

2. VIDEO SIGNAL ENCODING AND EQUIPMENT CONFIGURATIONS

2.1 Video Signal Encoding

The video signal encoding method of this equipment, is explained in the following, while referring to Fig.1 for a functional block diagram of the video signal encoding process (within the Encoder). Since the decoding process is just the reverse process of the encoding process, the description regarding the Decoder is omitted.

The "Video Preprocessing Section" handles the following component video signals: The number of effective pixels is 720 pixels for "Y" and 360 pixels for both "Cr" and "Cb", while the number of effective lines is 288 lines per field (for the 625 System). In order to be able to handle PAL or NTSC composite signals, a decoding circuit (or the coding circuit within the Decoder) is provided in the Encoder to convert composite signals into component signals.

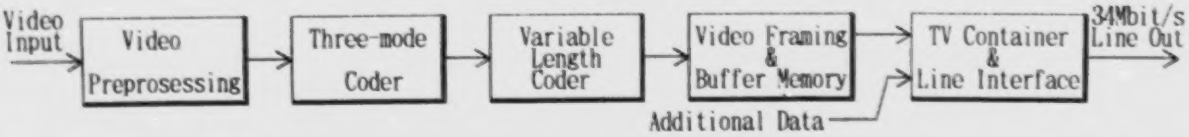


Fig. 1 FUNCTIONAL BLOCK DIAGRAM OF VIDEO SIGNAL ENCODING

Table1 MAJOR SPECIFICATIONS OF THE VIDEO CODEC

Input/Output Video signals		PAL/NTSC analog composite
		Analog component, Y(5.5MHz), Cb(2.75MHz), Cr(2.75MHz)
		Bit pararell digital component(ITU-R Rec. 656-1 part2)
Encoded pixels	Horizontal	720 pixels per line (Y) , 360 pixels per line (Cr and Cb)
	Vertical direction	288 lines / field (23 to 310 for Field1 , 336 to 623 for Field2 : 625) 248 lines / field (16 to 263 for Field1 , 278 to 525 for Field2 : 525)
Encoding (ITU-T Rec. 723)	mode	Intra-field , Inter-field , motion compensation inter-frame hybrid DCT
	DCT	Two dimensional DCT by 8 lines × 8 pixels
	Prediction	Inter-field prediction , motion compensation inter-frame prediction
	Motion compensation	Searching range : ±7lines x ±14pixels , Searching accuracy : 1/2 line , 1/2 pixel
	Quantization	Variable with each coefficient, Y/C, buffer memory occupation quantity , and block criticality
	Variable length coding	Applied to quantized DCT coefficients and motion vectors
Audio signals	Input/output signals	0dBm(typical) , +15dBm at an overload point , 4channels
	Encoding	384kbit/s per channels 14/11 instantaneous companding for 32kHz × 14bits (ITU-T Rec. J.41)
	Interface	600ohm , balanced , XLR-3 connector
Video error correction		Reed-Solomon[RS(255,239)] , 6-phase interleave
Interface with network		34,368kbit/s ± 20ppm , HDB3(ITU-T Rec. G.751) , 75ohm BNC connector
Power source		DC -48V ± 10% or AC 220V ± 10%
Dimensions and weight		483mm W (for mounting in a 19 in. rack) × 398mm H × 263mm D , approximately 18kg (for the Encoder and Decoder , respectively)

The encoding algorithm of the "Three-mode Coder" is roughly divided into three types: namely, algorithms applied to the intra-field mode, to the inter-field mode and to the motion-compensation inter-frame mode. According to the adaptive DCT method and signal quantization, redundant components in the time-space direction as well as visually redundant components are eliminated. Regarding motion estimation, both the tracing range and the tracing method are regulated with anaccuracy of a half pixel.

The "Variable Length Coder" processes the quantized DCT coefficient according to variable length coding. After being multiplexed with mode information, the "Video Framing & Buffer Memory Section" smoothes any deviation in the quantity of encoded data generated due to variable length coding by using the buffer memory with a capacity of 1.5Mbits, and then outputs signals at a constant rate. Then, the "TV Container & Line Interface Section" multiplexes error-corrected video signals into "TV containers" and

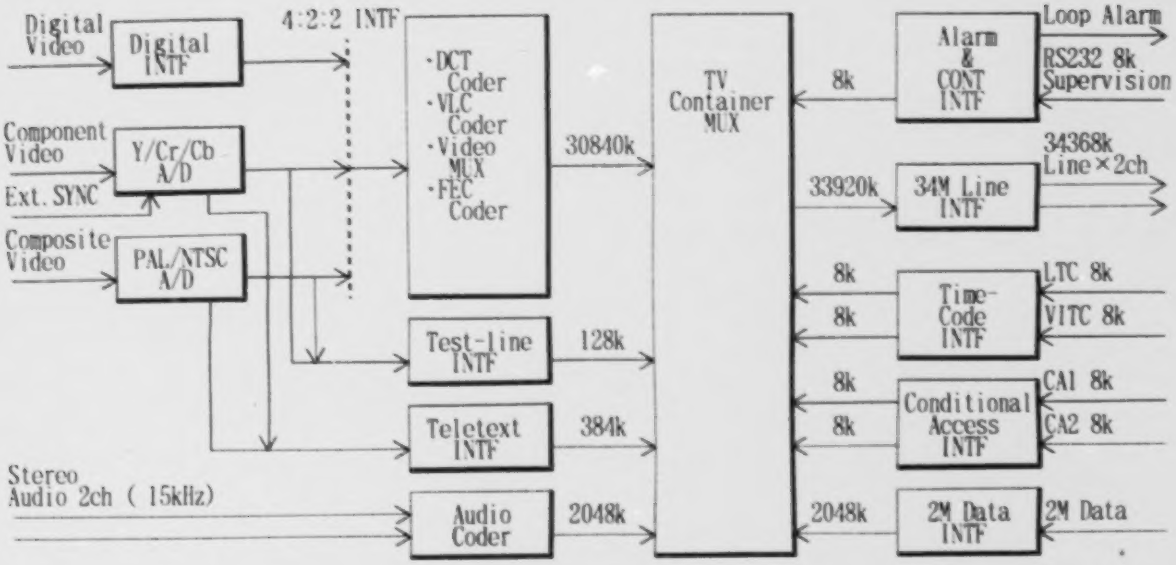

Digital Video
Digital INTF
4:2:2 INTF
Component Video
Y/Cr/Cb A/D
Ext. SYNC
Composite Video
PAL/NTSC A/D
·DCT Coder
·VLC Coder
·Video MUX
·FEC Coder
30840k
Test-line INTF
128k
Teletext INTF
384k
Stereo Audio 2ch (15kHz)
Audio Coder
2048k
TV Container MUX
8k
Alarm & CONT INTF
Loop Alarm
RS232 8k Supervision
33920k
34M Line INTF
34368k Line×2ch
8k
8k
Time-Code INTF
LTC 8k
VITC 8k
8k
8k
Conditional Access INTF
CA1 8k
CA2 8k
2048k
2M Data INTF
2M Data

Fig.2 FUNCTIONAL BLOCK DIAGRAM OF THE ENCODER

transmits them to a CEPT-system third digital hierarchical level, DS3 rate, 34.368 Mbit/s. For error correction, the Reed-Solomon code with six-phase interleave [RS (255, 239)] has been employed. Various data signals, including audio signals, are multiplexed into a TV container.

2.2 Equipment Configuration

This CODEC conforms to the ETSI standard regarding the video signal encoding section, although it has a configuration with various functions[5] as a CODEC for transmission, being capable of use by broadcast networks. Fig.2 gives a functional block diagram of the CODEC and Table1 lists the major specifications.

Both digital/analog component signals and PAL/NTSC composite signals can be accepted as the video input signal. These input signals are interfaced to the next circuit at the 4:2:2 level.

Audio signals undergo 14/11 instantaneous compand encoding, which conforms to the ITU-T Recommendation J.41, and 4-channel signals are converted to 2,048 kbit/s data before multiplexing. The ITU-T Rec. G.703 and the ITU-R Rec. 653 B method are employed for 2 Mbit/s data signals and teletext signals, respectively. For test line signals, VITS signals on the 17th to 20th lines are supported.

For other service data, both conditional access signals and timecode signals can be transmitted. This CODEC can also have capabilities for outputting alarm and control information related to itself to an external terminal. The High-Level Data Link Control (HDLC) protocol is used for communications with an external terminal. These data are transmitted to the receive side at a rate of 8 kbit/s.

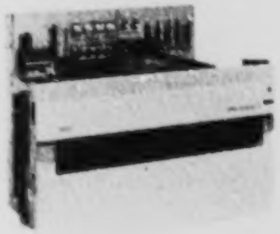
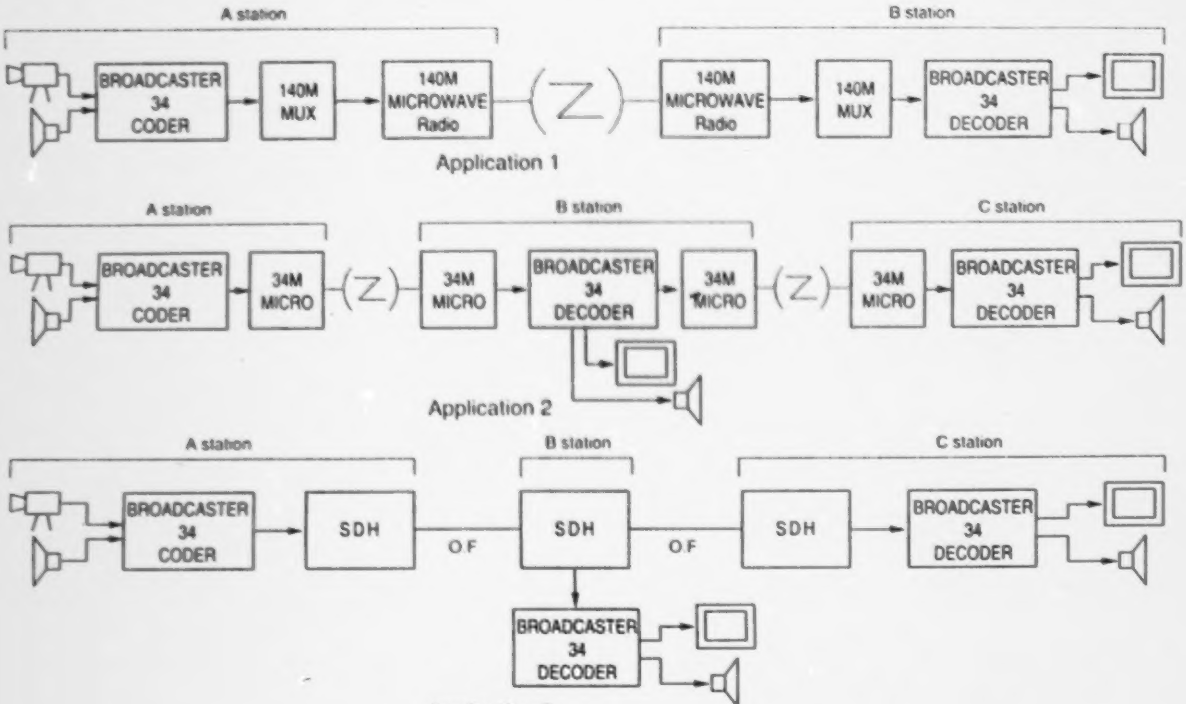


Photo1 EXTERNAL APPEARANCE OF THE ENCODER


A station
B station
BROADCASTER 34 CODER
140M MUX
140M MICROWAVE Radio
(Z)
140M MICROWAVE Radio
140M MUX
BROADCASTER 34 DECODER
A station
B station
C station
BROADCASTER 34 CODER
34M MICRO
(Z)
34M MICRO
BROADCASTER 34 DECODER
34M MICRO
(Z)
34M MICRO
BROADCASTER 34 DECODER
A station
B station
C station
BROADCASTER 34 CODER
SDH
O.F
SDH
O.F
SDH
BROADCASTER 34 DECODER
BROADCASTER 34 DECODER

Application 1

Application 2

Application 3

FIG.3 EXAMPLE OF A SYSTEM APPLICATION

In order to easily access the front side, the terminal box is located at the upper side of the equipment. Both the Encoder and the Decoder are separately mounted in a subrack of 483mm (19in.) W x 398mm H x 263mm D. Photo1 shows the external appearance of this equipment.

2.3 Example of System Configuration

This equipment is mainly targeted at the transmission and distribution of broadcast video signals for program materials as a video signal transmission CODEC within a digital broadcast network which uses digital micro-wave or SDH backbone transmission lines. Fig.3 gives an example of a system application for a broadcast network.

3. DEVELOPMENT OF GATE-ARRAYS AND ADOPTED LSI

3.1 Development of Gate-arrays for Encoding

The encoding section mainly comprises the adaptive DCT encoding loop circuit as well as the quantizing circuit. The loop circuit uses three types of prediction modes, including the intra-filed mode, the inter-field mode and the motion-compensation inter-frame mode. The quantizer is controlled by such parameters as the transmission factor related to the buffer-memory

Table2 MAJOR SPECIFICATIONS OF THE NEWLY DEVELOPED GATE-ARRAYS

	LOOP Gate-Array	QNT Gate-Array
Encoding method	ITU-R Rec.723 ITU-T Rec.H.262 MPEG2 Video	ITU-R Rec.723 ITU-T Rec.H.262 MPEG2 Video
Major func.	Predictive-encoding, frame-memory control	Quantizing, inverse quantizing, zigzag scan conv.
Num. of gates	82K gates	67K gates
package	304-pin QFP	160-pin QFP
Process	CMOS 0.6μm	CMOS 0.6μm
Clock	13.5MHz	13.5MHz
voltage	+5V	+5V
Power	430mW(max)	260mW(max)

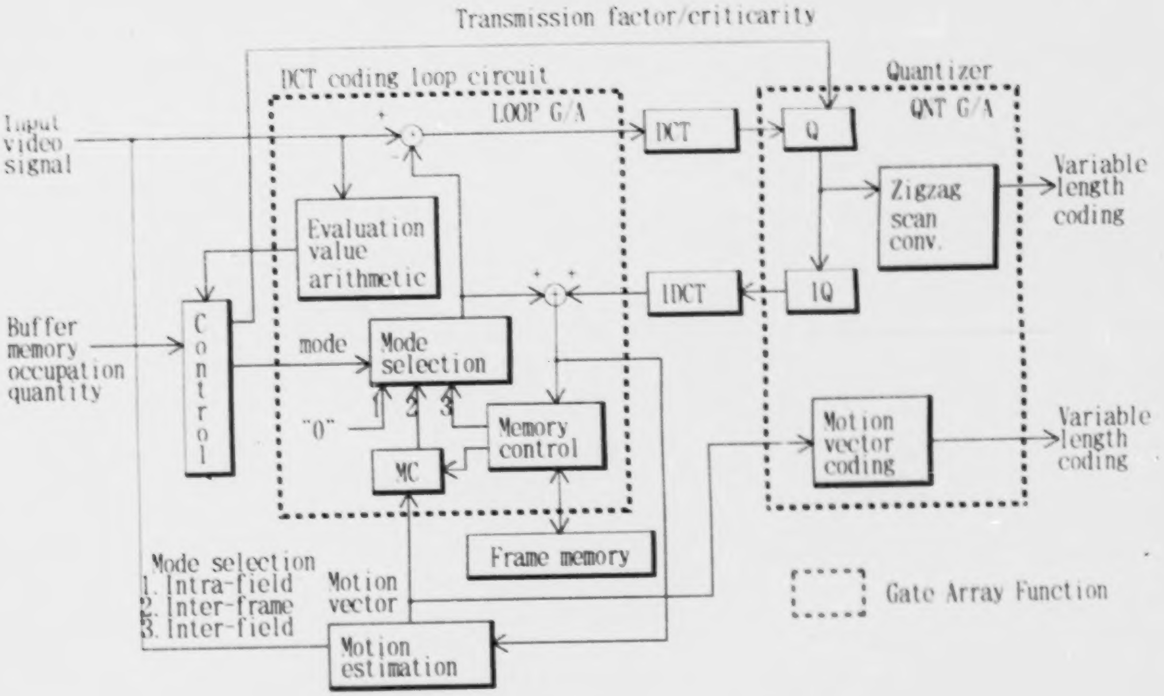

Transmission factor/criticarity
DCT coding loop circuit
LOOP G/A
Quantizer
QNT G/A
Input video signal
Evaluation value arithmetic
DCT
Q
Zigzag scan conv.
Variable length coding
IDCT
IQ
Buffer memory occupation quantity
Control
mode
Mode selection
"0"
2
3
Memory control
MC
Motion vector coding
Variable length coding
Frame memory
Mode selection
1. Intra-field
2. Inter-frame
3. Inter-field
Motion vector
Motion estimation
Gate Array Function

Fig. 4 FUNCTION BLOCK DIAGRAM OF THE ENCODING SECTION

occupation quantity as well as the criticality that reflects a local change of signals. The motion vector used in the motion-compensation inter-frame prediction mode is detected by an accuracy of a half pixel. Fig. 4 shows a functional block diagram of the encoding section.

In order to implement the above-mentioned encoding loop circuit and the quantizer, we have taken advantage of the similarity between the circuit configurations of the encoding sections specified by both the ITU-R Rec. 723 and MPEG2 [6] and have developed two types of gate-arrays. As shown in Fig. 4, these gate-arrays have flexible configurations, taking functional expansion into account, by externally connecting circuits for encoding control, motion-vector estimation, frame memory, DCT and inverse DCT. These gate-arrays can also be appliedto the Main Profile @ Main Level encoding method for MPEG2, by only changing a few peripheral circuits.

Both gate-arrays were developed by adopting a technique of converting circuits into logical gates using the logical synthesizing tool after the VHDL design. Table 2 lists the specifications of these gate-arrays.

3.2 Employment of LSI and FPGA

(1)Employment of LSI

In order to decrease the size and power consumption of the equipment, LSI circuits have also been adopted in each functional block. The LSI chip which separates (decodes) and synthesizes (encodes) Y/C signals was used for conversion and reverse-conversion from composite signals to component signals at the 4:2:2 level. The DCT (inverse-DCT) specific LSI chip was employed in the video signal encoding section; likewise, the motion-vector estimation LSI chip was used for motion-compensation inter-frame prediction, the word-shifting LSI chip was used for time-axis compression/expansion of variable length coded or run length coded data, and the Reed-Solomon encoding LSI chip was for error-correction encoding/decoding.

(2)Employment of FPGAs

The design of this equipment includes the so-called Field-Programmable Gate-Arrays (FPGAs), which have recently received much attention. This implements reduced size and low power consumption as well as the reduction of development costs, compared to that required in the development of a new gate-array.

These FPGAs were mainly used in adaptive prediction judgment, calculations for motion-vector estimation with a half-pixel accuracy, control of variable length coding, buffer-memory control, and TV container or 34 Mbit/s framing.

4. MOTION-VECTOR ESTIMATION WITH HARF-PIXEL ACCURACY

4.1 Effectiveness of Motion-Vector Estimation with Half-Pixel Accuracy

The Detection of the motion-vector is an essential function [7] for the video CODEC, which can provide the capability for highly efficient video signal compression by calculating any motion from the previous frame according to a differential value between frames.

According to the ETSI standard, the motion-compensation (MC) used in the inter-fame mode should have an accuracy of a half pixel within a range of ±14 pixels in the horizontal direction and ±7 lines in the vertical direction. There is no specific regulation for implementing this requirement.

The effect of using motion-compensation with one-pixel accuracy is well known. Motion-compensation with a half-pixel accuracy can further improve the SNR by approximately 2 dB compared with the effect obtained by the one-pixel accuracy MC. However, if entire tracing using the 2-step tracing method, such as MPEG2 Test Model 4, is employed, the disadvantage is an increase in the hardware size and complication of the circuit.

4.2 Half-Pixel MAE Estimation Method

In order to solve the above-mentioned disadvantage, we have employed the half-pixel Mean-Absolute-Error (MAE) estimation method [8] as one simplified solution for the half-pixel accuracy MC, by which MAE can be estimated without generating any half-pixel MC images. Fig. 5 gives a conceptual figure of this method.

As shown in Fig. 5, a motion-vector is first detected using the entire tracing method with one-pixel accuracy so that the value of the vector from a reference point can be minimized [such a vector is referred to as MAE(0)]. Then, MAEs of 8 vectors around this motion-vector are calculated, resulting in MAE(1) through MAE(8). Further, interpolated MAEs of 8 vectors around MAE(0) are calculated, resulting in MAE(1') through MAE(8'). Thus, the value of vector of MAE(i') with the half-pixel accuracy determined by the estimated coefficient(S) can be given by the following equation:

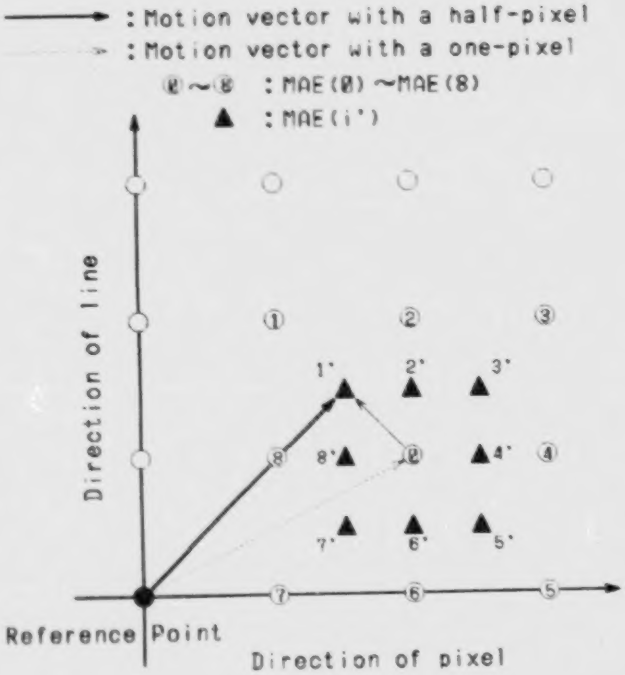


Fig. 5 CONCEPTUAL FIGURE FOR VECTOR DETECTION WITH HALF-PIXEL ACCURACY REFERENCE POINT

$\mathrm{MAE}\ (I') = S \times \{\mathrm{MAE}(0) + \mathrm{MAE}(I)\}$, -------- Eq. (1)
where $I = 1, 2, 3, \ldots\ldots 8$.

By sequentially comparing MAE(0) and MAE(1') through MAE(8'), a vector which gives the minimum value is the optimum vector, which becomes a motion-vector with a half-pixel accuracy.

4.3 Result of Simulation

Fig. 6 shows the result of a simulation performed against two kinds of reference video images

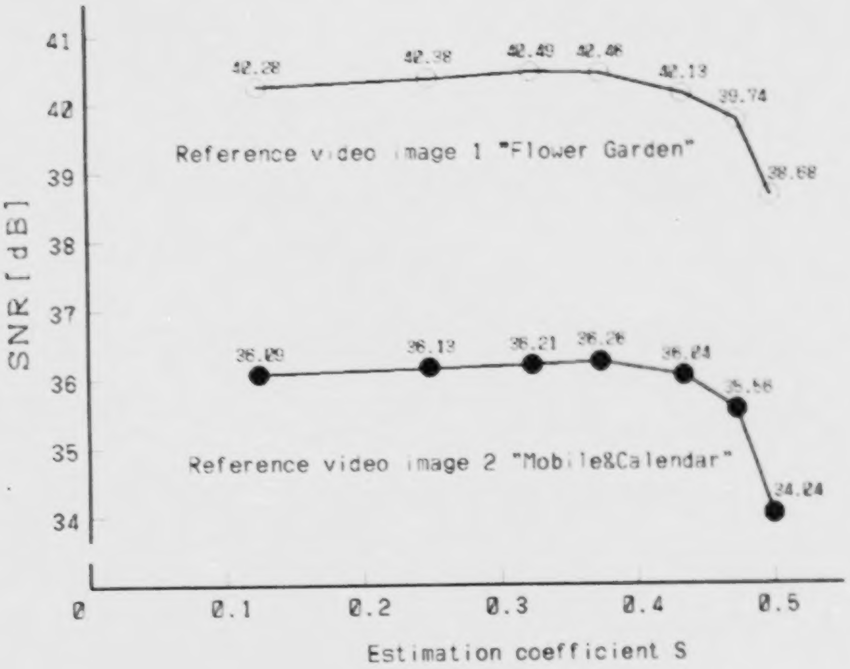


Fig. 6 SIMULATION RESULT

while arbitrarily changing the estimation coefficient(S). As shown by this figure, the value of S, which gives the maximum SNR, is around S=0.375. Since any value equal to or less than 0.375 makes a difference of only about 0.1 dB, we have selected S=0.25 as a possible value while taking into account a simplification of the hardware.

Furthermore, according to the simulation result, we have verified that this method can improve the SNR by 1.70 up to 2.09 dB compared to that obtained by one-pixel accuracy MC. We have confirmed that the above-mentioned value can produce a performance that is in no way inferior to that for the entire tracing MC with a half-pixel accuracy. Note that the size of the hardware adopting this prediction method was approximately 1/3 of that for the entire tracing method with a half-pixel accuracy.

5. CONCLUSION

We have developed the CODEC for video signal transmission with broadcast quality which conforms to the encoding method specified by the ETSI standard. For implementing this equipment, we have developed gate-arrays which are capable of being applied to the MPEG2 signals. In addition, by using various LSI chips and FPGAs, the size and power consumption of the equipment could be reduced. Furthermore, by employing our original MAE estimation method with a half-pixel accuracy, the size of the hardware could also be reduced.

The characteristic evaluation tests, including those for the basic image quality, post-processing image quality and transmission error characteristics, have shown that all of the test results could meet the requirements [9] which the ITU-R has regulated as the specifications for the transmission of broadcast program materials.

We hope that this new equipment will meet the future demand in Europe due to the digitalization of broadcast networks as well as the adoption of the same standard in North America.

We appreciate those who kindly instructed us concerning the development of this equipment.

REFERENCES

[1]N. Suzuki, et al., "Information Preserving Coding for Broadcast Television Signals", Proc. IEEE Globecom '82. Nov. 1982, pp. B. 6.5.1. 1982

[2]T. Shibuya, et al., "Adaptive DPCM for Broadcast Quality TV Transmission of Composite NTSC Signal", Proc. SPIE VCIP '93. Nov. 1993, pp. 434 -443, vol. 2094.

[3]CCIR/CMTT, "Recommendation 723, Transmission of Component Coded Digital Television Signals for Contribution-quality Applications at the Third Hierarchical Level of CCITT Recommendation G.702", 1990.

[4]ETSI, "ETS 300 174 - Digital Coding of Component Television Signals for Contribution Quality Applications in the Range 34 - 45Mbit/s", Nov. 1992.

[5]L. Cheveau and R. Miles, "EBU User Requirement for ETS 300 174 Codecs", EBU Technical Review Winter, pp. 14 - 19 (1993).

[6]ISO - IEC/JTC1/SC29/WG11, "Generic Coding of Moving Pictures and Associated Audio", IS 13818 - 2, 1994.

[7]B. Griod, "Motion-Compensating Prediction with Fractional Pel Accuracy", IEEE Trans. Com., Vol.41,No. 4, pp. 604 - 612, 1993.

[8]Y. Senda, et al., "A Simplified Motion Estimation Using an Approximation for the MPEG-2 Real Time Encoder", ICASSP - 95, 1995.

[9]CCIR, Recommendation 500 - 3, "Method for the Subjective Assessment of the Quality of the Television Picture", 1988.

Hybrid Sync/Async Distance Learning Options at the University of California Santa Cruz Extension and Marpet University

V.C. Marney-Petix

Director, Network Management Certificate, UC Santa Cruz Extension (Santa Clara) & Curriculum Director, Marpet University (Fremont), California, USA

Abstract

The University of California Santa Cruz Extension and Marpet University have been experimenting with new distance learning modes. The San Francisco Bay Area has a large population, requiring alternatives to traditional live training. A new approach, combining the advantages of synchronous and asynchronous distance learning, is examined.

The University of Santa Cruz has embarked on an ambitious Asynchronous Transfer Mode (ATM) trial. In addition, both this University and my private post-graduate training organization, called Marpet University, have been experimenting with other distance learning options. UCSC Extension is responsible for serving the post-graduate, non-degree learning needs of an ethnically and linguistically diverse, physically-scattered population in the southern half of the San Francisco Bay Area and in the Monterey Bay area. The Monterey Bay population exists 40 miles south of the SF Bay, separated from it by part of the Coast Range, thus creating two distinct populations. The major UCSC Extension campus is in Santa Clara, one of the cities collectively referred to as Silicon Valley, while the UCSC campus, which awards conventional degrees, is in Santa Cruz, part of the Monterey Bay community of cities. The total population to be served totals over 6 million people, of whom 2 million are adults potentially interested in telecom education.

Persons who want to take degreed courses must physically go to Santa Cruz, while those who want post-grad continuing education and certificated retraining programs must physically commute to one of four cities in the densely-populated, traffic-congested and spread-out Silicon Valley. The terrain and available roads between Silicon Valley and Monterey make commuting unfeasible without a great deal of effort. Extension course have traditionally been evening and weekend. Weekend courses, while useful in other ways, are very stressful for distance travelers, who need the two non-commute days to rest up from the normal workweek!

The ATM connection is specifically designed to allow adult post-baccalaureate learners to complete advanced degrees in Computer Engineering without completing an exhausting commute of up to 4 hours round-trip from their jobs and homes in Silicon Valley. In addition, existing Network Management and Network Engineering courses in the post-graduate certificate programs, as well as other certificate courses, will be transmitted to the Santa Cruz and Monterey communities, making non-degree adult certificate learning available to these professionals.

I have innovated late afternoon and lunchtime live classes to serve the needs of this population by integrating education into their workdays and keeping them out of evening commuter hell. However, in this paper I will focus exclusively on one of the two distance learning options I have been experimenting with.

Needs of the Population To Be Served

The UCSC Extension and Marpet University populations are very similar in their needs. At this time of transition, hundreds of thousands of workers are either displaced or desirous of improving their employment options by continuing their education in telecom subjects. They especially want certificates, as concrete proof of competency for employers and potential employers. They are not currently being well-served by our standard live, instructor-led education options.

Problems include:

1. Distance/traffic

Californians have a reputation for traveling long distances to work, school and entertainment. However, as discussed, it just isn't possible for many residents of the two bays to commute to classes. More and more people are moving to central valley cities for quality-of-life reasons, adding more distance. It takes 45 minutes to commute from one end of the UCSC service area in the SF Bay area to another, with light traffic. These distances are just too large. Live meetings require people to be physically present with each other. (We call this **synchronous learning**, discussed in detail later.)

2. Traffic

Heavy traffic stemming from stubborn insistence on single-occupant driving means that even relatively small distances can take an enormous time toll. It takes almost an hour to travel 10 miles in Silicon Valley during peak commute times, which is the evening slot for most live classes.

3. Time stress, multiple roles

Equally importantly, most adults in this area are juggling careers (with long hours because of economic uncertainties), families' needs and their other needs, with little flexibility. Live classes that require a person to be physically present in a specific place and time require many people to scratch a potential education experience off their list of tasks. Some people have a "window" of energy and time in the early morning, while others are most productive at midnight. No organization can allocate resources for enough classes to cover all possible contingencies. The exhaustion and stress of their normal lives also means that these workers cannot waste precious time in traffic, commuting long distances.

4. Labor Practices

Employers are generally not supportive of employees getting the education they need during working hours, on employer time. Employers in this area typically put additional requirements on workers seeking education, refusing to reimburse tuition costs for other than traditional, live, 30-hour, 1-evening per week courses.

Needs of Education Organizations

Education organizations, including both public and private institutions, find themselves facing challenges in trying to serve the needs of this very demanding constituency.

1. Limited number of experts

True telecom experts are a precious resource that must be husbanded. "Burning out" a good instructor is an ever-present threat, if they try to teach too many classes. There simply aren't enough people who are willing to eschew high consulting fees in order to teach.

2. Need to be cost effective

Training organizations, including Universities, must generate more revenue without increasing costs. Using instructor skills more effectively with distance learning will improve the cost/benefit ratio for organizations. Lowering facility rental, on-site support and other costs is all possible if we consider non-facility-based training.

Distance Learning Options

Synchronous distance learning, such as ATM and other videoconferencing technology offers, has many advantages. Students can ask live questions and other students can hear the answers and benefit. Live interactions stimulate additional learning and synergistic thought. In sync learning, many students can interact with a single instructor, so you have economies of scale in reaching students.

Asynchronous learning frees you from the constraints of time and location. People can learn at 6 AM or at midnight, and at every time in-between. Time zones don't matter. The instructor's funny accent doesn't matter. Working parents, people in Norway, evening-shift programmers in Monterey - everyone can learn effectively. Async learning seems ideally suited to serve the needs I listed above, for workers in this part of the world, with their time, traffic and distance challenges.

I admit that I didn't take async learning seriously until I had the privilege of visiting Massey University in Palmerston North, New Zealand. Many professionals there generously shared their perspectives and expertise with me. Massey has been a leader in async distance learning for adults for as long as I've been alive (I'm older than I look) and Massey opened my eyes to the advantages of async. PTC member Dr. Graham Wagner of the NZCER introduced me to Massey.

With all of its advantages, async learning has disadvantages. The isolation of pure async learning saps your willpower, stagnates your thinking and does not allow you to get immediate feedback and course correction when you head in the "wrong" direction. In addition, individual coaching to aid learning is time-consuming for instructors. You have no economies of scale in reaching learners for interactions. You, as an institution, have to create materials that do more than just present dry facts. Your materials need to stimulate thought and activity; you need reviews, summaries, quizzes and projects.

Human beings seem to need regular live or simulated-live interaction for optimal learning effectiveness. In addition, there is the undeniable "straggling" issue, in which learners put off work that is not linked to deadlines involving live confrontations with exasperated instructors.

Finally, learners (and everyone else, including the reimbursement authorities) still take education more seriously when it is in the familiar live mode. Those who research distance learning options have encountered many objections from those who find new modalities uncomfortable, leading to the expressed belief that only live teaching is "real" education.

Both UCSC and Marpet University have been looking for ways to generate maximum training effectiveness for attendees, while lowering costs and being more efficient with limited teaching staffs.

The two non-ATM training modalities I have experimented with are: 1) adding competency testing and distance learning components to static videos and 2) Shared Learning. In this paper, I will focus on the latter.

Shared Learning

What I call Shared Learning is a way to combine the advantages of sync and async learning, while eliminating most of the disadvantages of both. Here are the core elements:

- Students receive a complete self-paced workbook. Luckily for me, I write books for Numidia Press that are self-paced tutorials, so I didn't have to create the materials specifically for these classes; I just used existing books. Some additional books were also given to the students, for background reading. The Numidia books have reviews, summaries and hand-in quizzes for each chapter. This keeps the learners on track and gives the instructor a tool for assessing competency. This was an async component of the training.

- Students had their needs for sync learning and interaction with fellow learners taken care of through study groups of students from the same class. The study groups were assigned based on physical proximity to each other, level of learning and other factors. Each student had a choice to join any study group and in fact, some were more than normally nomadic and joined 2 or more! I made an effort to direct the less-prepared and/or language-challenged students to groups with more-prepared students. This was the primary sync learning mode.

Students were expected to meet with their study group to resolve any problems that their self-study had left unresolved. These meetings were scheduled at least once per week.

- Students had live, face-to-face class meetings with their instructor for 1-2 hours every 2-3 weeks. These were milestone dates for completed-work turn-in. Students who could not attend could have their study group deliver completed materials. To prevent "straggling," these dates were absolute. No materials turned in on a particular date meant no grade for that checkpoint. The only exceptions I accepted, and I announced this at the first class meeting, were major earthquakes and mudslides, flooding, tsunamis or firestorms of the entire city, etc. Students did have an opportunity for extra credit projects to restore points lost through schedule conflicts, family vicissitudes, accidents, forgetfulness and - most prevalently - not believing the instructor really meant "no exceptions." (For cultural reasons, this may be a particular problem with US/California students.)

Live meetings with the instructor were also the time for questions and answers (Q&A) on issues that the study group could not resolve.

• Students had live, though not in-person, contact with their instructor and with each other through two technologies: 1) telephony office hours and 2) AOL chat.

- The students were able to call in to the instructor for quick Q&A during designated telephone office hours. This helped to resolve confusion quickly, gave the student live, sync contact with the instructor and required no one to travel.

- Students were invited to go to an interactive "chat room" set aside for the students of this class on America Online (AOL), an online service provider with Internet linkages. AOL is the most popular online provider in the USA. Chat days and times were set in advance and lasted no more than 90 minutes. Students needed to have a modem (most do, of course) and needed to be subscribers to AOL, which is very inexpensive. AOL has local access numbers in most moderate-sized (over 50,000 population) US cities, and has a growing non-US subscriber base, so AOL chat is available for almost all potential students. (One student was in Norway!)

In interactive chat, students were able to ask questions live. The advantage of this over telephony is that the instructor can answer questions once, for everyone. Here we have the one-to-many advantage of sync learning, for the instructor and the organization, coupled with the async advantage of no travel required.

• Students had async contact with the instructor and with each other through Internet email. Most students had Internet accounts through their employer, and some had AOL accounts (which they also used for chat.) Students were able to check on procedural issues (is the design project due on Tuesday?) as well as ask about technical issues that confused them.

• The final exam is a comprehensive individual assessment vehicle that must be completed in the instructor's presence. I set up makeup dates for some students who had the usual crises on the scheduled date. The final exam tests the true competency of the person who desires a letter grade, and acts as a check to the inevitable minority of students who will let others do the studying and try to pretend competency they haven't worked for. With this final check looming over their heads, the temptation to cheat wasn't strong and we could all relax and allow maximum leeway to the students' legitimate needs.

Results

Results to date cover 2 quarters at UCSC Extension and 1 quarter at Marpet University, too small a sample size for rigorous statistical analysis. However, the numbers are large enough for preliminary analysis.

Higher Numerical Scores

1. Network Architectures, a core required course at UCSC and Marpet University, covering LAN basics

I examined numerical point scores for 15 Shared Learning students compared to 52 students in live classes in Network Technology, taught by the same instructor. I also compared 12 Network Technology students in an identical Marpet University class to the UCSC live classes and to Marpet University live classes. I looked at each population separately, then combined the two Shared Learning populations and the two live populations. Trends were the same for Marpet University and UCSC Extension.

Students in the Shared Learning classes earned higher point scores on quizzes and the final exam; 7 extra points gave these students a half-grade point advantage. When I broke out scores for the LAN design project and for individual tests, I saw a much sharper picture. Scores in Shared Learning groups rose sharply as the quarter progressed, indicating a trend that the arithmetical mean disguised. Clearly, students performed better as they became comfortable with the process of Shared Learning. No such trend exists in live classes. Lazy, exhausted or poorly-prepared students sometimes improve as the class progresses, but not as dramatically as Shared Learning did.

I plotted grades vs. frequency of study group meeting and found a mild correlation. Students who met more often earned higher grades. (But see a different story with the advanced class.)

I would like to be able to plot point scores vs. attendance in specific modalities, like AOL chat. This would provide feedback on the impact of these high-tech sync learning modalities on student learning. I would also like to plot use of email and telephony office hours, but there are insufficient numbers for analysis as yet.

2. Bridges, Routers, Gateways, Switches (BRGS), an advanced class

I examined 7 Shared Learning students in this advanced class, compared to 23 live learners in the same class at UCSC Extension, with the same instructor. I also examined 4 Shared Learning students from a Marpet University class and 16 live learners in an identical class. It's important to keep in mind that this is both an advanced class and a very intensive format. Students in live UCSC classes need to absorb 135 pages of material over two Saturdays and the intervening week, so an A requires extensive self-study.

It should be no surprise that As are less common in this live class than they are in Network Technologies, notwithstanding the more-prepared and more homogeneous nature of the students. As in the more elementary class, I looked at each population separately, then combined the two Shared Learning populations and the two live populations. As before, I discovered that trends were the same for Marpet University and UCSC Extension.

Students in the Shared Learning BRGS classes earned substantially higher point scores on quizzes and the final exam; 4 students earned A+s, which are unprecedented. In this classes, the difference between the final grades of the Shared Learning and the live students was a startling 14 points. No Shared Learning student earned a B, compared to 5 live students. As in Network Technology, scores in Shared Learning groups rose sharply as the quarter progressed.

I plotted grades vs. frequency of study group meeting and found no correlation. Some well-prepared students omitted study groups because they didn't need the help. Four of the well-prepared students, however, chose to attend regular study groups and live meetings with the instructor. In interviews, I asked them why. Two said they went to make sure they "weren't missing anything." I suspect that these four students also went to study groups for the human interaction. All mentioned that it was good to "see another face" to stay on track and motivated - which is an advantage of sync vs. async learning.

These results should also be a call to action to university administrators who are enamored of Saturday classes. It is very clear that the Shared Learning students, with 8 weeks to study the material, vastly outperformed the 2-Saturdays students. Especially with a time-stressed population like this one, intensive live classes don't deliver the competency results that Shared Learning can.

Qualitative Results

Qualitatively, I found the Shared Learning students frightened of the process during the first class but very enthusiastic after the final exam. Students seemed prepared for the test, answered questions readily in class and asked more thought-provoking, more complex questions, both live and in chat and email. The Shared Learning students have also stayed in touch with the instructor more than students in live classes, sharing successes. I believe that this stems both from a belief that the instructor really cares about them and from a greater sense of responsibility for the process, which I will discuss next.

Students also came away feeling good about the experience and the instructor.

Benefits for the Institution

Shared Learning has been an economic boon for UCSC, Marpet University and the instructors involved. An instructor can spend an hour live with Shared Learning students, clearing up 2-3 chapters of problems, compared to 6-9 hours of lecture. Of course, instructors have to be compensated for telephony office hours, chat sessions, etc., but the time commitments and stress levels are a small fraction of the toll a live class takes. An instructor can work with larger groups, or more classes. Of course, larger groups require more coordination work, keeping students on track.

Success: Why?

The success of Shared Learning is undoubtedly due to its partaking the benefits of both sync and async learning modes. In addition, qualitative interviews with the participants have helped me to a preliminary understanding of the underlying reasons for this fine showing: Students in Shared Learning take responsibility for their own learning. Without me as crutch to do the work for them, they have been forced to change their mind-set and approach the task of learning differently. They knew that learning success depended on them - and they rose to the challenge. Students in Shared Learning finally understood that all real learning comes from the combination of excellent material, excellent coaching and guidance AND the application of self and group energies.

ATM

The University of California Santa Cruz ATM link was turned on in November and is currently running an economics class, but at press time the first class was not complete, so I have no effectiveness data to report. I encourage interested professionals to contact me for continuing data on the ATM trial. I hope that I can share results with you, examining ATM, static video/coaching combos and Shared Learning options, at PTC '97.

Remote Engine Inlet Simulation Over ACTS: Why Aren't We There Yet?

Saragur M. Srinidhi*, David E. Brooks*, Steven C. Lin*, Isaac Lopez~

*Sterling Software (US) Inc,
NASA Lewis Research Center, MS 142-1
21000 Brookpark Road,
Cleveland, OH 44135

~NASA Lewis Research Center, MS 142-5
Interdisciplinary Technology Office,
21000 Brookpark Road,
Cleveland, OH44135

ABSTRACT

The potential application of satellite networks towards the delivery of ATM services is described. ATM techniques are at present under consideration for the evolution of terrestrial networks towards broadband capabilities. This paper is based on the framework of an exploratory study in ascertaining the viability of IP-over-ATM over a high data rate satellite channel provided by NASA's Advanced Communications Technology Satellite (ACTS) satellite. With the longer delay (on order of hundreds of milliseconds) introduced in the network by the satellite link, upper layer protocol implementation issues will significantly impact application performance. Accurate and intelligent link characterizations will allow for developing strategies to lessen the impact on application performance when using a long delay path. Several TCP performance optimizations minimizing discovered bottlenecks will be evaluated for this network and application. The methods include increasing TCP buffer space, and identification of ATM flow control issues.

INTRODUCTION

The propulsion system simulator is one of the technologies being developed at NASA Lewis Research Center (LeRC) to allow the U.S. aerospace industry to be more technologically and economically competitive. However, the current communication networks connecting LeRC to its industrial collaborators cannot provide the necessary bandwidth for flow visualization.

This study was conducted to ascertain the viability of current data protocols over a high data rate satellite channel provided by the ACTS satellite. In this setup, Boeing Aerospace Company based in Seattle, WA, communicated via the ACTS channel with the Cray YMP connected to the ATM network at NASA LeRC. Traffic studies were conducted on the "numerical wind tunnel" prototype using high speed computing and communications in place of a conventional wind tunnel. This experimental network was among the first integrated demonstrations of advanced high speed technologies in support of state of the art aeronautical and network research.

Experimental Motivation

There is interest in developing a capability of supporting geographically distributed computing. This would allow more effective resource sharing and improved utilization of computing resources. However, the propagation delay between two computer systems can severely hamper the achievable performance. In this paper we consider both application and network issues, define possible solutions and then illustrate the results of those solutions as implemented. We are primarily concerned with geographically distributed computing, and use the NASA ACTS satellite to investigate this problem. This poses a particularly extreme situation since the propagation delay is on the order of hundreds of milliseconds. A major issue to be examined is the use of ATM-based local-area and wide-area networks in distributed computing. In particular, a primary goal of this work is to assess the suitability of an IP over ATM-based network to support the inter process communication and remote file I/O system requirement of distributed computing.

The cost of implementing new technology in aerospace propulsion systems is becoming prohibitively expensive. One of the major contributors to the high cost is the need to perform many large scale system tests. Extensive testing is used to capture the complex interactions among the multiple disciplines and the multiple components inherent in complex systems. The objective of the Numerical Propulsion System Simulation (NPSS) is to provide insight into these complex interactions through computational simulations. This will allow for comprehensive evaluation of new concepts early in the design phase before a commitment to hardware is made. It will also allow for rapid assessment of field-related problems, particularly in cases where operational problems were encountered during conditions that would be difficult and expensive to simulate experimentally with a full hardware mock-up. The tremendous progress taking place in computational engineering, the rapid increase in computing power expected through parallel processing, and availability of high performance communications technologies make this concept feasible.

The traditional design and analysis procedure decomposes a complex, aerospace system into isolated components and focuses attention on each single physical discipline (e.g. fluid dynamics or structural dynamics). Consequently, the interactions that naturally occur between components and disciplines can be masked by the limited interactions that occur between individuals or teams doing the design and analysis. This can pose serious problems for a highly integrated propulsion system, where interactions between individual subsystem will have unforeseen effects on overall system performance. If the coupling is not identified until the system has been built and tested, then the system must undergo redesign and retesting. Typically, several iterations of the design-build-test cycle are required before desired performance is achieved. This is an extremely costly and time consuming process. As a result, the introduction of advanced technology takes many years as these systems slowly evolve. The need exists to reduce the time and cost associated with introducing new technology. This can be achieved through optimizing existing design practices and through introducing a higher level of concurrent engineering into the design process such as NPSS.

NPSS is a top-down systems approach providing designers with tools to incorporate the relevant factors that affect system performance early in the design and analysis process, when changes or modifications can be made relatively inexpensively. In terms of a propulsion system, such as an air-breathing gas turbine engine, this means coupling of disciplines and components computationally to determine system attributes such as performance, reliability, stability and life. Since these system attributes have traditionally been obtained in the test cell, NPSS is referred to as a "numerical test cell". A complete system analysis encompassing multiple disciplines is a computational intensive task requiring a variety of computing platforms, including massively parallel processors and a user interface consisting of expert systems, data base management systems and visualization tool. These resources are geographically distributed across the country to spread the cost of this system.

The integrated, interdisciplinary system analysis requires advancements in the following technologies: (1) interdisciplinary analysis to couple the relevant disciplines such as aerodynamics, structures, heat transfer, chemistry, materials, and controls; (2) integrated system analysis to couple subsystems, components and subcomponents at an appropriate level of detail; (3) a high performance computing platform composed of a variety of architectures, including massively parallel processors, to provide the required computing speed and memory; and (4) a simulation environment providing a user-friendly interface between the analyst and the multitude of complex codes and computing systems that will be required to perform the simulations; and (5) a very high performance reliable network.

The objective of this paper is to determine the performance characteristics and associated overhead, particularly in the context of a high speed network in a large propagation-delay environment. TCP is used in this paper as the network data transport. Operating system issues such as buffer moves, and protocol overhead are important issues but are dwarfed by the potentially devastating performance impact of the large propagation delay. This paper quantifies the performance impact on TCP-based applications and propose ways to circumvent the limitations.

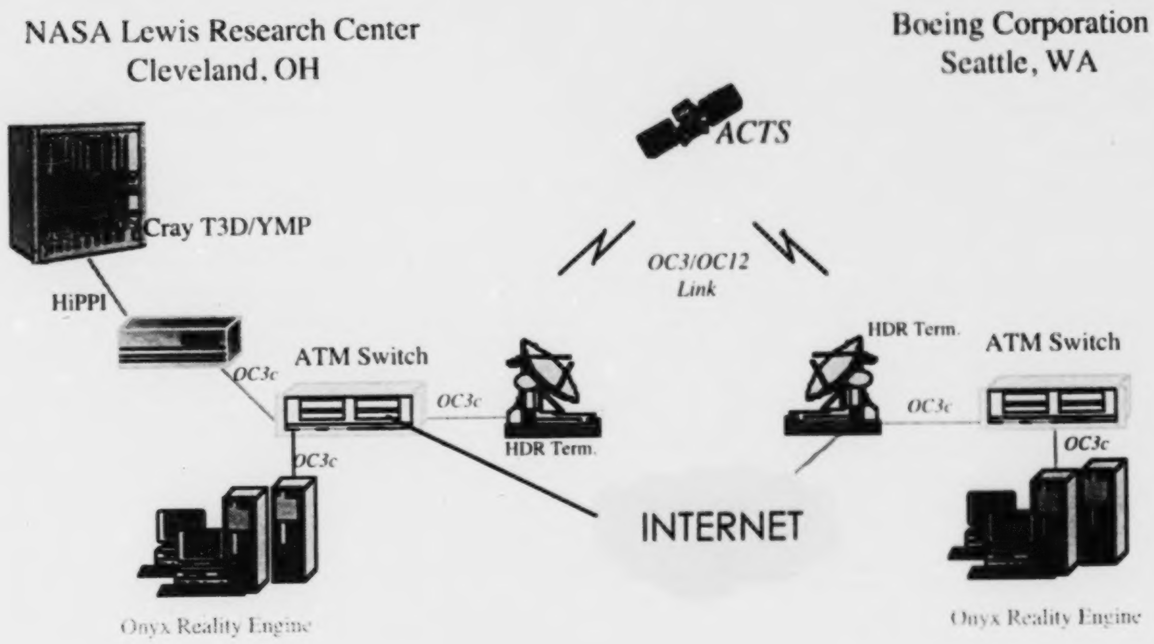


Figure 1. Experimental Layout

Figure 1 illustrates the basic scenario of the investigation. The objective is to support high-performance computing across the ACTS satellite, using a supercomputer on one side of the country to execute the application and an other machine thousands of miles away for visualization in real-time. A primary objective of this effort was to assess the impact of the propagation delay on the performance of distributed computing applications. A major impact to performance is the software structure that must be supported. In particular, TCP is used as the network transport protocol between Boeing and LeRC.

Transport Protocol Issues

Two software programs were used in these investigations[1]. First was *ttcp* , a public domain program used initially to measure application throughput, and then modified to measure "Application Latency" (defined below). We also used *tcpdump*, another public domain program, to monitor the advertised TCP window sizes and MSS. "Application Latency" may be defined in several ways. For this paper, it was measured using the following procedure. *ttcp* was modified so that just prior to each write() function, a timestamp was placed at the start of the data to be written. When the receiving *ttcp* application returned from the read() function which returned this timestamped portion of the message, it immediately sent a UDP message containing this original timestamp back to the transmitting *ttcp* application. Finally, when this UDP message was received by the transmitting *ttcp*, the timestamp was compared to the current time and the difference considered to be the "application latency". The term is used because the latency is measured from the time when the transmitting application first passes the timestamp to the kernel (via write()), until the kernel finally passes the timestamp back to the original application.

PERFORMANCE:

MTU Size: *ttcp* was used to measure the application throughput as a function of MTU size. For each trial, 64 KB blocks were sent. The amount of data was always 120 times the TCP window size (see TCP Slowstart section below for more details). The MTU of the ATM interface was varied from 8 KB to 64 KB, in 8 KB increments, for each run, with the TCP window size constant. Several runs were made, with TCP window sizes ranging from 64 KB to 4096 KB. Later in Figure 6, we show the application throughput in four representative runs, with TCP window sizes of 1024 KB, 2048 KB, 3072 KB, and 4096 KB. From this figure, it can be seen that the MTU size does not play a significant role in the throughput, except at very low MTU/high window size combinations.

TCP Window Size: Again, *ttcp* was used to measure the application throughput. This time, however, the TCP window size was the independent variable. In addition, a modified version of *ttcp* was used to measure application latency as a function of TCP window size. Again, 64 KB blocks were sent, with a total data amount equal to 120 times the size of the TCP window. The TCP window size was varied from 64 KB to 4096 KB in 64 KB increments.

Figure 2: Throughput vs. TCP Window Size

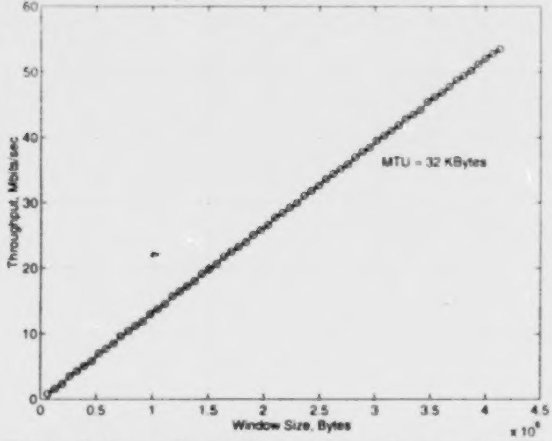


Figure 2 shows the application throughput as a function of TCP window size with a MTU size of 32 KB (which exhibited typical results). This figure shows a very linear relationship between throughput and window size. The dotted line in this figure is data from Bellcore, showing the theoretical maximum throughput as a function of window size for the ACTS link used. Our results match this theoretical maximum very well.

Figure 3: Latency vs. Window Size

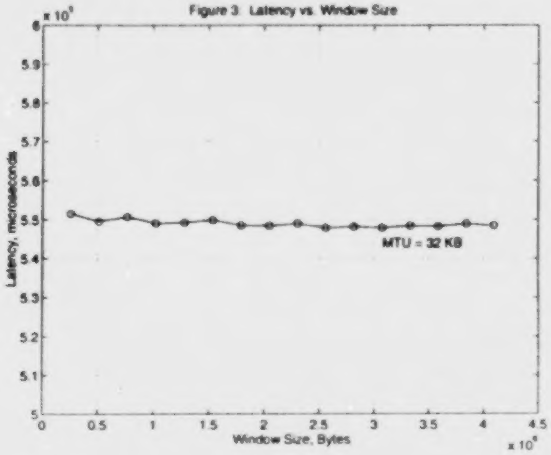
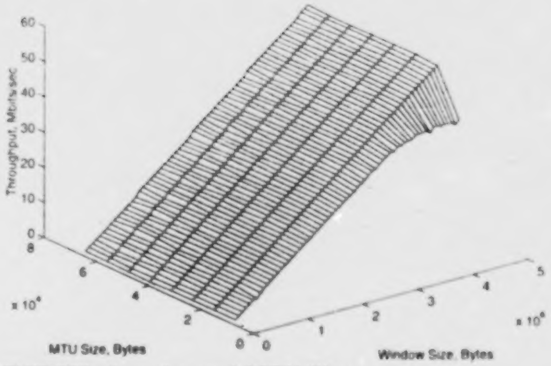


Figure 3 shows the measured application latency as a function of TCP window size (again for an MTU size of 32 KB). As expected, the latency was generally constant at approximately 540 ms.

Figure 4: Throughput vs. MTU Size and Window Size

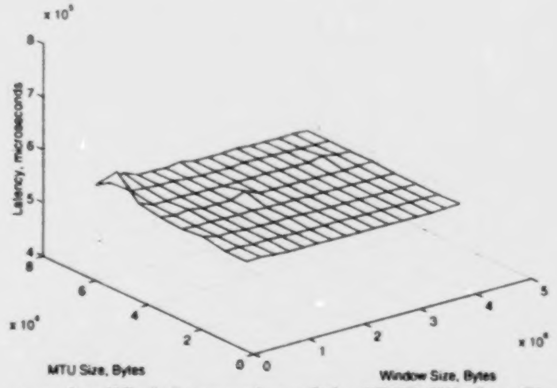


TCP Window size and MTU Size sensitivity:

Figure 4 shows a 3 dimensional plot of application throughput vs. both MTU size and TCP window size[2][3]. Figure 5 shows the effect of these parameters on application latency. These plots basically summarize the last two sections, showing that: a) Latency is relatively constant, b) MTU size in the range tested has no major impact on performance, and c) increasing the TCP window size increases throughput linearly.

TCP Slowstart: The above analysis somewhat oversimplified the meaning of the "TCP Window Size". In actuality, the EFFECTIVE TCP window size is the minimum of a) the TCP window size referred to above (actually the amount of buffer space allocated to the TCP socket) and b) the congestion window. The congestion window, in turn, is controlled by the TCP Slowstart behavior. In general terms, this behavior is used to prevent congestion of terrestrial networks by preventing a TCP transmitter from blasting a large amount of data at once over a network. Instead, the transmitter must transmit only one segment when beginning a transmission, then wait for an acknowledgment from the

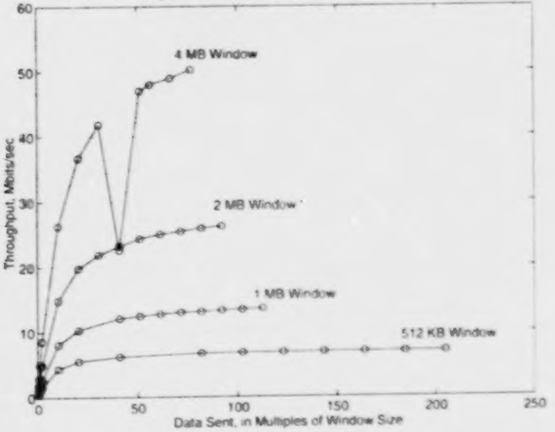
Figure 5: Latency vs. MTU Size and Window Size



receiver. When one is received, the congestion window doubles, and two segments are allowed to be outstanding on the network before an acknowledgment is received. When this *ack* is received, the congestion window again doubles. This continues until either some segments are dropped by the network, indicating congestion, in which case the congestion window gets smaller, or else some operating system dependent maximum is reached. During the time that the congestion window is smaller than the socket buffer size (the TCP Window Size mentioned in previous sections), the effective, advertised TCP window is the congestion window[3][4]. At the point where the socket buffer size is smaller than the congestion window, the advertised window is the socket buffer size. In effect, then, the TCP window size mentioned previously is actually a maximum value for the advertised TCP window, reached only after slow start has ramped up the congestion window to a large value.

In the case of these ACTS experiments, congestion should not have been a problem, since we had connected only two machines together with a link rate equal to the maximum interface data rates of both machines. So in the above experiments, the congestion window monotonically increased until it was larger than the socket buffer size, and after this point, the socket buffer size was the true advertised TCP window size. However, recall that the round trip delay for this connection is approximately 540 ms and the theoretical maximum throughput is 155 Mbps, yielding a bandwidth delay product of {~84E6bits}. On this type of a "long, fat pipe", a great deal of data needs to be sent before the congestion window has enough time to increase to the point where the socket buffer size is the true TCP window size. In our tests, we eventually decided on sending 120 times the TCP window size in order to insure that enough data was being sent to regard the socket buffer size as the true TCP window size. It turns out however, that this is quite a lot of data (approximately 640 MB for a 4096 KB TCP window). In practical uses of a satellite network, it must be expected that not all transmissions will be of files of this size. We decided to characterize the effect of Slowstart on various file sizes using various TCP window sizes. The method used was as follows. Again, *ttcp* was used to measure throughput of the network. This time, however, the amount of data was significantly smaller than 120 times the window size. Figure 6 summarizes the results, showing measured throughput as a function of the amount of data sent. In this figure, the data amount is expressed as a multiple of the TCP window size. That is, for the 512K window, the data point at x=122.9 was measured with a data amount of 122.9 * 512KB = 62.9 MB. As can be seen from Fig. 6, as the amount of data involved in the transfer increases, the overall transfer rate increases. The exponential curve of these plots is consistent with expected TCP Slowstart behavior. The problem that this plot points out is as follows. In order to obtain the highest throughput possible, it is necessary to have a large TCP Window size (as demonstrated earlier). However, even with a large window, high throughput is not seen unless a large amount of data is sent through the socket (enough to push TCP well beyond the Slowstart region.) In fact, with a 4 MB window, even sending 50 times the window size (which is 200 MB), the throughput hovers around 48 Mbps, roughly 10% below the maximum for that window size[5]. As the amount of data sent becomes smaller, the problem becomes even worse.

Figure 6 Throughput vs. Amount of Data Sent



CONCLUSION

This paper has presented the performance effects of some TCP parameters on a IP over ATM network with satellite elements. The following effects were seen:

- Application latency is more or less constant, fixed at the link latency.
- Interface MTU Size had very little effect on throughput. (At very small MTU there was a slight degradation in throughput, but for all others throughput remained constant).
- TCP Window Size affected throughput greatly. As expected, throughput increased linearly with the TCP window size.
- TCP Slowstart has a very detrimental effect to throughput when smaller amounts of data are sent. (Note small is a relative term here, data sets as large as 200 MB or more can be affected.)

Therefore, a large TCP window is necessary for good throughput on a high latency link. Also, TCP Slowstart can have very negative effects on throughput. Most TCP implementations do not allow the user to disable Slowstart (and for good reason - this would overwhelm many terrestrial networks without providing much benefit). However, if TCP/IP is to be used for moderate sized file transfer over satellite networks, it would prove useful to look in to ways of disabling TCP Slowstart for certain operations

In conclusion, an NPSS application using TCP as the transport protocol on an high latency satellite link is severly impacted when issues such as small receive buffers, delayed acknowledgments and slow start are not addressed. Addressing these problems can reduce the performance degradation somewhat by increasing the receive buffer space used by the application, but the problem is not solved. This problem is just postponed, and will soon return as data rates continue to increase. Further study will be necessary to explore this realm of next generation of NPSS applications. References [6] and [7] demostrate the results of using an alternative application data transport called PVM instead of TCP. They also indicate further study is necessary.

BIBLIOGRAPHY:

[1] W. R. Stevens, "TCP/IP Illustrated, Vol1 The Protocols", Addison-Wesley, 1994

[2] M. Lin, J. Hsieh, D. Du, J. Thomas, and J. MacDonald, "Distributed network computing over local atm networks," Tech. Rep. TR-94-17, Computer Science Department, University of Minnesota, Minneapolis, Minnesota, 1994.

[3] C. E. Bagwell and J. N. Daigle, "ATM Cell Delay and Loss for Best-Effort TCP in the Presence of Isochronous Traffic," in Proc. IEEE INFOCOMM '94, pp. 9a.2.1--9a.2.9, June 1994.

[4] A. Romanow and S. Floyd, "Dynamics of TCP Traffic over ATM Networks," in Proc. SIGCOMM '94, pp. 79--88, October 1994.

[5] B. J. Ewy, J. B. Evans, V.S. Frost and G.J.Minden, "TCP/ATM Experiences in the MAGIC Testbed," Communications of the ACM, 1994.

[6] P. Dowd, E. Blade, S. Srinidhi, and R Claus, "Issues in ATM support of high performance geographically distributed computing", in Proc. IPPS'95 Workshop on High Speed Networks, (Santa Barbara, CA), pp. 352-358, April 1995.

[7] D. E. Brooks, T. M. Carrozi, P. W. Dowd, I. Lopez, F. A. Pellegrino, S. M. Srinidhi "ATM Based Geographically Distributed Computing Over ACTS", Proc. NASA ACTS Results Conference, Cleveland, OH, September 1995

Satellite Delivery of Wideband Services by ACTS

Douglas Hoder and Michael Zernic

NASA Lewis Research Center
Cleveland, Ohio USA

(dhoder@lerc.nasa.gov, mzernic@lerc.nasa.gov)

Abstract: In order to for a satellite system to deliver wideband services compatible with terrestrial fiber networks, several major technological obstacles needed to be overcome. The solutions used in the ACTS Gigabit Satellite Network provided varying levels of success. Three major concerns prevail.

The first set of problems concerns channel bandwidth and signal quality. Most terrestrial networks are capable of providing bandwidth in excess of 622 Mb/s (SONET OC-12) on a single fiber, and at error rates of less than 10^{-12}. Although the ACTS satellite is capable of providing bandwidth for SONET service up to the OC-12 level, the construction of a ground station network required to utilize the ACTS bandwidth and get adequate error performance presented a major challenge.

Another issue associated with SONET service over satellite is the physical layer compatibility with terrestrial SONET equipment and networks. These were dealt with throughout the design and integration of the GSN. The satellite TDMA system and terrestrial interfaces were designed specifically to accommodate SONET service. The integration of the network was done in a manner of increasing network complexity, beginning with simple point-to-point connections, and finishing with interconnection of existing terrestrial fiber SONET and ATM testbeds.

The final concerns arise from the incompatibility of the satellite path latency with communications protocols existing in the machines and applications connected to the network.

1) Introduction--Fiber vs Satellite

A space-based communications network can provide three primary functions--operating alone, as a bridge between isolated terrestrial networks, or as an extension to remotely-located terminal equipment.

Operating independently, a space-based network can interconnect remote or even mobile terminals. The obvious applications are for temporary, portable equipment, vehicular systems, aircraft and marine. Such systems usually incorporate proprietary equipment and protocols. These are in general, not compatible with terrestrial data networks.

As a bridge, a satellite can interconnect two or more terrestrial networks located in geographically remote locations. In this application, it is a requirement that the space-based service either conform to the protocols of the interconnected networks, or be capable of somehow terminating these protocols, in order that the data may be passed between and routed through the two networks.

As an extension, a space-based system can serve to connect remote or mobile nodes in a network. This is basically the same configuration as the bridge. However, the protocol problem may be somewhat easier to solve, as the ground station usually serves as an isolated node, with no routing beyond its local network. Thus, the protocols can be terminated at the ground station.

Further applications of satellite-based systems include the establishment of temporary service and alleviation of congestion in terrestrial systems.

603

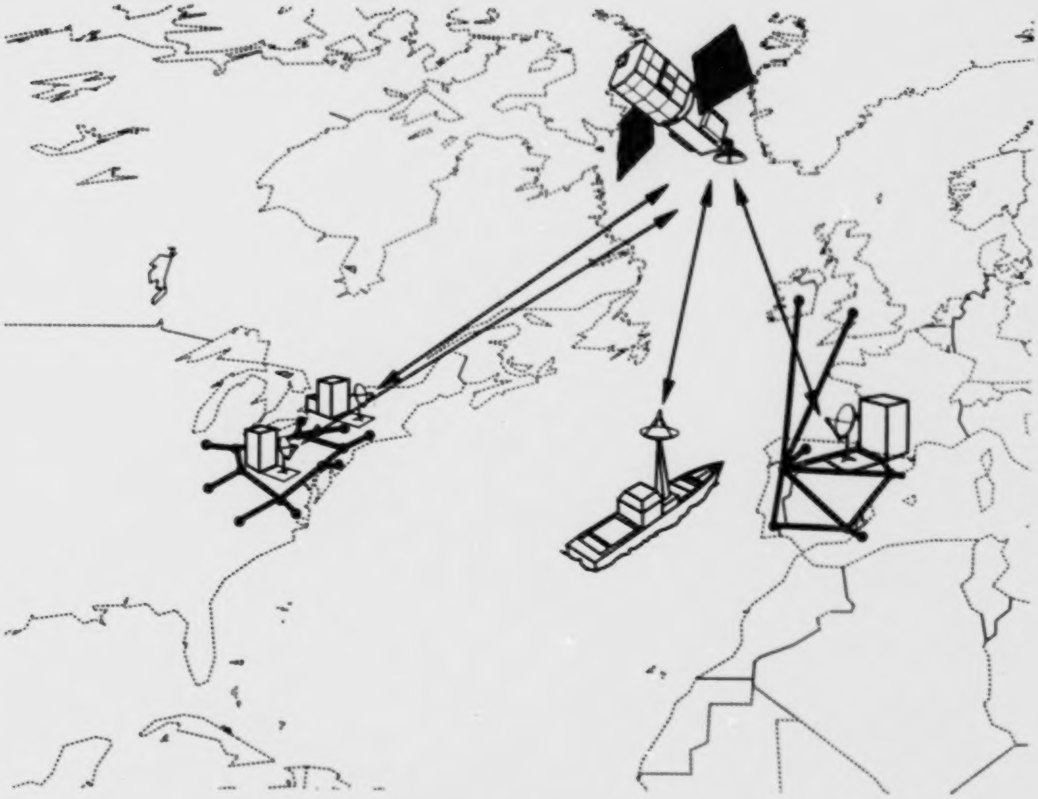


Figure 1: Satellite/Terrestrial Connections

1a) *Satellite Applications*

The wideband service suggested herein refers to applications requiring bandwidth on the order of tens to hundreds of MHz or transfer rates of the same magnitude (e.g., SONET, ATM, B-ISDN). Such wideband services are normally intended for delivery over optical fiber. When the fiber is available, this is probably the most practical form of delivery. However, there are situations in which a space-based network can be advantageous.

There are several inherent access capabilities of satellite systems which make them highly attractive for certain applications. Space-based systems can easily provide access to:

i) remote sites, anywhere within their field of view
ii) mobile sites, such as ships at sea, motor vehicles, or aircraft.

Additionally, a satellite link can:

iii) be established on a temporary basis, for special events
iv) be used to bypass a congested or damaged terrestrial network
v) provide "bandwidth on demand".

The constraints on such capabilities include the capabilities of the satellite(s) used, and the capabilities and logistics of the ground stations. utilizing the satellite(s).

1b) *ACTS and the GSN*

The NASA Advanced Communications Technology Satellite (ACTS) has the bandwidth and routing capability to provide wideband, networked interconnections [1]. The High Data-Rate (HDR) Ground Stations used in the ACTS Gigabit Satellite Network (GSN) were designed to provide fiber-like service. The ground stations and the system software were constructed by BBN Systems and Technologies (Cambridge, MA) and Motorola Government Systems and Technology Group (Scottsdale, AZ) under a program jointly funded by NASA and ARPA. For a detailed description of the GSN, please see [2,3,4].

2) Bandwidth and Signal Quality

Two of the most advantageous characteristics of optical fiber are its virtually unlimited bandwidth and its inherently low bit-error rate (on the order of 10^{-11}). Conventional satellites, on the other hand, typically have bandwidth on the order of tens of MHz, with link bit-error rates in the range of 10^{-5} - 10^{-6}. This type of performance is adequate for applications such as low-rate data and television distribution, but in order to provide fiber-like service, both the bandwidth and signal quality of the satellite links must be improved.

The ACTS satellite "transponder" has a bandwidth of at least 800 MHz* [5]. This is sufficient to pass a 622 Mb/s data stream, with overhead, using Offset-QPSK modulation (the null-to-null bandwidth of the main lobe of the modulated signal is 696 MHz). Unfortunately, the best raw channel bit-error rate that can be achieved at these rates with the ACTS is about 10^{-6}--inadequate for compatibility with fiber-based service. However, in the Gigabit Satellite Network, ultimate bit-error rates of 10^{-11} - 10^{-12} are achieved by using Reed-Solomon block coding.

The Reed-Solomon encoding has two inherent characteristics which are ideally suited to this specific application: byte interleaving and a very high coding gain. (although the two are interrelated). Satellite links often suffer from bursts of errors--as opposed to uniformly distributed error arrivals. The byte interleaving protects against such bursts of errors by re-distributing received errored bits across many codewords, which have a small number of correctable errors in each. The high coding gain overcomes the somewhat weak satellite bit-error rate performance by providing post-FEC bit-error rates of better than 10^{-11} with input BERs of 10^{-5} or greater.

In the HDR ground stations, the Reed-Solomon coding is performed by an integrated circuit manufactured by LSI Logic (Milpitas, CA). As a further enhancement of signal quality, the HDR ground stations utilize a dual-rate burst satellite modem, which can provide channel throughput at 622 Mb/s (in QPSK mode) or 311 Mb/s (in BPSK mode)--the BPSK mode providing more than 3 dB of extra margin (the actual burst rate of the modems is either 696 or 348 Mb/s). The selection of mode is made on a burst-by-burst basis, i.e., a channel can be configure to use either modulation scheme.

Typical received carrier-to-noise density ratios are from 101 to 104 dB Hz. Corresponding performance numbers are indicated in Table 1.

Table 1: ACTS GSN Typical BER Performance

received C/N_o (dB Hz)	mode	E_b/N_o (dB)	link throughput rate (Mb/s)	raw channel BER	post-FEC BER
104	QPSK	15.6	622	2×10^{-6}	$< 10^{-11}$
101	QPSK	12.6	622	8×10^{-5}	$< 10^{-11}$
104	BPSK	18.6	311	$< 10^{-11}$	$< 10^{-12}$
101	BPSK	15.6	311	4×10^{-11}	$< 10^{-12}$

**--Due to the hard-limiting characteristic of the ACTS transponder channel, the absolute bandwidth is not well defined. It is however, possible to pass the above mentioned signal through the channel without irrevocable degradation*

The minimum C/N_0 required for post-FEC BER of less than 10^{-11} is about 100 dB Hz for a QPSK channel, and about 94 dB Hz for a BPSK channel. This yields rain fade margins between 1 and 4 dB for QPSK, and between 7 and 10 dB for BPSK. To date, the system has exhibited no link failures due to rain.

The combination of the wide satellite transponder bandwidth and the error performance of the HDR ground stations provides links of sufficient bandwidth and quality similar to that of optical fiber.

3) Terrestrial Compatibility

3a) *Networking*

Traditional satellite service consists of point-to-point links, which are run either continuously or in a TDMA-mode. The ACTS satellite can mimic a multi-node network through it's switchable electronically-hopped antennas and its microwave switch matrix. These two features provide true SS-TDMA (satellite-switched time-division multiplex) capability.

The satellite can provide three simultaneous uplinks and three downlinks, their locations on the earth and their interconnection switchable on either 1 or 32-µsec boundaries. By programming the microwave switch matrix and the antenna spot selections, mesh connections can be made between several ground stations in the network, each acting either as isolated terminal or as a node in a terrestrial network.

In the GSN, the ground stations' terrestrial interface ports are connected to local fiber networks, and the ground stations and satellite are configured to provide SONET OC-3 or OC-12 connections between these ports. The local networks are then interconnected through the satellite network.

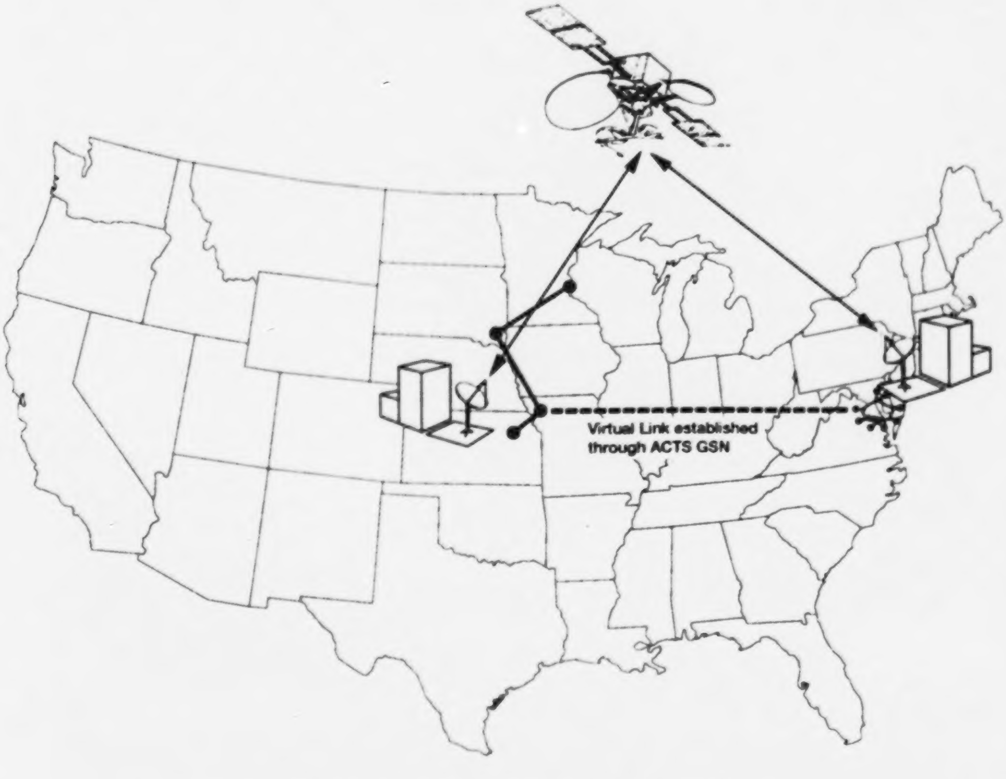


Figure 2: Network Interconnection via the ACTS GSN

3b) SONET

To be compatible with terrestrial networks, it is necessary for a space-based network to conform to the OSI system of protocol layers. The GSN provides connectivity at Layer 0--physical layer.

The input and output ports to the ground stations are SONET OC-3 or OC-12 optical interfaces. The GSN serves as SONET Line Terminating Equipment (LTE) and will support most of the SONET overhead functions. The details are provided in Table 2 [3].

Table 2: Support of Section and Line Overhead Functions in the SONET Interfaces of the Gigabit Satellite Network

Section Overhead	
Framing and STS-1 ID	yes
Section Error Monitoring (BIP-8)	yes
Section DCC, Section Orderwire, and User Channel	no
Line Overhead	
Pointer Bytes and Pointer Action Byte	
- Frequency justification	yes
- Alarm Indication Signal (AIS)	yes
Automatic Protection Switching (APS)	
- Line switchover	no
- Far End Receive Failure (FERF)	yes
Line DCC and Line Orderwire	no

In the uplink direction, the incoming STS-1 components of a non-concatenated STS-3 or STS-12 signal first have their payloads separated from their section and line overheads, and are then individually aligned to an internal 32-msec frame signal, which is phase locked to the satellite MSM frame. The STS-1 signals stripped from their section and line overheads (payload plus-payload-pointers only) are then routed independently over satellite to different earth stations. In the downlink direction, the outgoing OC-3 or OC-12 signal is built first by assembling the aggregate signal from received STS-1 payload plus-payload-pointer bytes originating in different earth stations, and then by multiplexing these payload signals with locally generated SONET section and line overhead bytes.

3c) *ATM*

The transmission of ATM cells poses no inherent difficulties to the GSN, or any satellite network that provides similar physical-layer compatibility. As no routing or processing of the cells is performed by the satellite network itself, the ATM cells are simply transmitted and received through the SONET Line Terminating Equipment--the satellite network serves as a "wire" between ATM switches.

The overriding problem with ATM over satellite arises from the criterion used for discarding errored cells. In normal ATM header processing, the cell is discarded ("dropped") if more than one of the header bits is errored, and cannot be corrected by the header CRC. If a "dropped" ATM cell constitutes the entire 424-bit cell being errored, it can be argued [9] that the BER of an ATM link is approximately 17,000-times the channel BER. With the typical bit error-rates provided by optical fiber (usually better than 10^{-11}), this is not a problem. However, with the typical satellite link BER of 10^{-6} - 10^{-7}, the ATM link is simply unusable. The FEC used in the GSN alleviates this problem, and ATM has been used extensively with this system [7].

4) Latency and Higher Level Computer Communication Protocols

4a) *Transport Layer*

The major obstacles encountered with wideband computer communication over a geostationary satellite link are due to the latency introduced by the distances to and from the satellite. The path length to geostationary orbit is approximately 35600 km. This gives a delay of approximately 120 msec from the ground to the satellite, or 240 msec for each round trip. In the case of protocols requiring acknowledgments for packets (such as TCP), the wait is now 480 msec (almost one-half second). With an OC-3 connection, this means that there are about 10 MB "in the pipe" before an acknowledgment can be received, i.e. the delay-bandwidth product for this situations is about 10 MB. In order get any real throughput from this sort of delay-bandwidth constraint with TCP requires the TCP window size to be increased to as large as possible.

Srinidhi has demonstrated [7] throughput to 58 Mb/s (for TCP), and UDP throughput approximately 120 Mb/s (after including allowances for various protocol overheads) using a TCP window size of 4 MB and OC-3 (155 Mb/s) connections through the ACTS GSN. It is important to note that the TCP throughput is a direct function of the window size available with the software and hardware used for the application.

4b) *Modifications*

In order to get reasonable throughputs with this order of delay-bandwidth product, certain modifications need to be made to the transport layer protocols. Some possibilities include:

i) increase window sizes
ii) replace Stop_and_Wait with a Go_Back_N protocol for acknowledgments
iii) defeat TCP slow start and related parameters that effect performance on long round-trip transit delay links.
iv) use direct routing where possible.

5) Application Experience

5a) *The Lewis-Boeing Experiment*

This was the first application experiment performed with the GSN. This ACTS experiment explored the implementation of a "numeric wind tunnel", through the remote use of a NASA Cray supercomputer. A workstation at Boeing was linked into an ACTS high data rate earth station at their Seattle, WA facility. The other earth station was connected to the Cray via the campus ATM fiber network at NASA Lewis Research Center in Cleveland, OH. [7].

The path at the Lewis (Cray) end consisted of the ground station SONET ports connected through a Fore ATM switch into the Lewis ATM network. The Cray connected to the same ATM network in two ways; either by a proprietary Cray device (Cray Bus-Based Gateway), or a Gigarouter.

At the Boeing end, the ground station was connected to a matching ATM switch. A workstation with an ATM interface was also connected to the same switch. The workstation provided the user interface to the Cray. An experimental ATM traffic processor was also inserted into this network to collect traffic statistics.

The application used to permit distributed processing between the Cray and the workstation is known as PVM (Parallel Virtual Machine). The rest of the protocol stack consisted of modified TCP, IP, ATM, and finally SONET.

As stated earlier, by modification of the TCP window size to 4 MB, and various other adjustments, throughputs of 58 Mb/s (for TCP), and 120 Mb/s (UDP) were possible. The 4 MB window size was a limitation of the workstation. With a larger window size, the throughput can be increased.

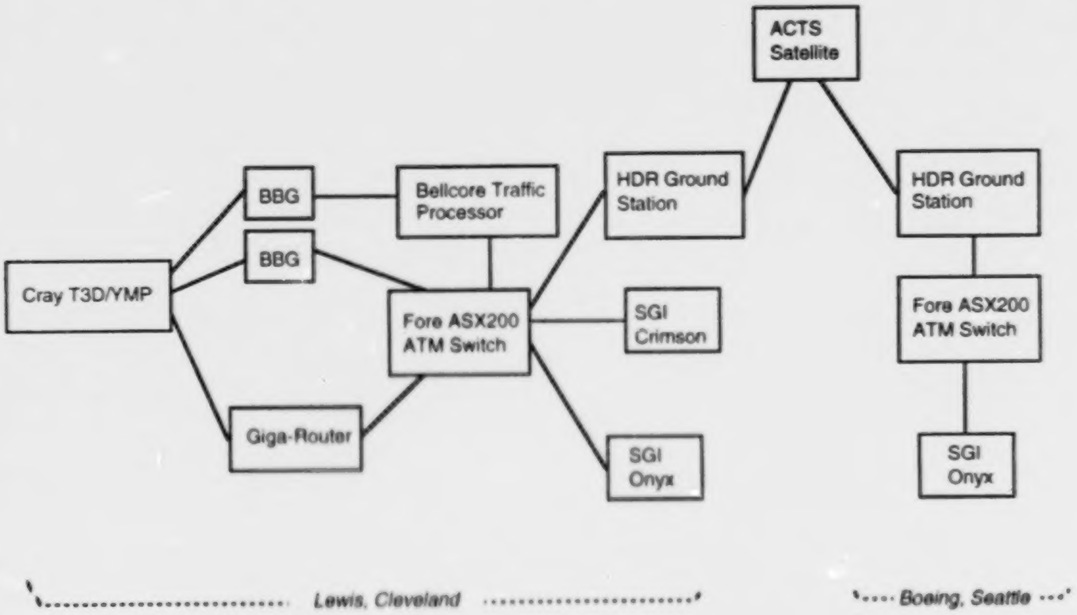

ACTS Satellite
BBG
Bellcore Traffic Processor
HDR Ground Station
HDR Ground Station
BBG
Cray T3D/YMP
Fore ASX200 ATM Switch
SGI Crimson
Fore ASX200 ATM Switch
Giga-Router
SGI Onyx
SGI Onyx
Lewis, Cleveland
Boeing, Seattle

Figure 3: Lewis/Boeing Experiment Hardware Configuration

5b) *The NCAR-OSC Experiment*

The experiment consisted of the interconnection of two Cray supercomputers, one at the National Center for Atmospheric Research (NCAR) in Boulder, CO and the other at the Ohio Supercomputing Center (OSC) in Columbus, OH. The two supercomputers interactively exchanged large numerical models of atmospheric and lake conditions for the modeling of climate simulations in the Great Lakes area. This enabled meteorological and marine forecasting through the use of complex supercomputer models and access to unique and geographically diverse resources. In addition to enhanced conventional audio and visual techniques, this multiple site collaboration used a video whiteboard which allowed for interactive drawing, writing, and posting of images and text [8].

The Crays were connected without an intermediate ATM network. Each Cray's HiPPI bus interface was connected to a proprietary HiPPI-to-SONET converter, developed by The Los Alamos National Laboratory. The SONET ports of the converter were then connected to the ground stations via a HiPPI switch. The switch is connected directly to the ground station ports. The hardware at each site was identical.

This experiment also used PVM for the distributed processing. The rest of the protocol stack was TCP, IP, HiPPI, down to SONET.

The Cray machines permitted a larger window size (10 MB) than the workstation in the Lewis/Boeing experiment. With the 10 MB window, NCAR has achieved throughputs over 120 Mb/s with TCP, in a 155 Mb/s OC-3 channel.

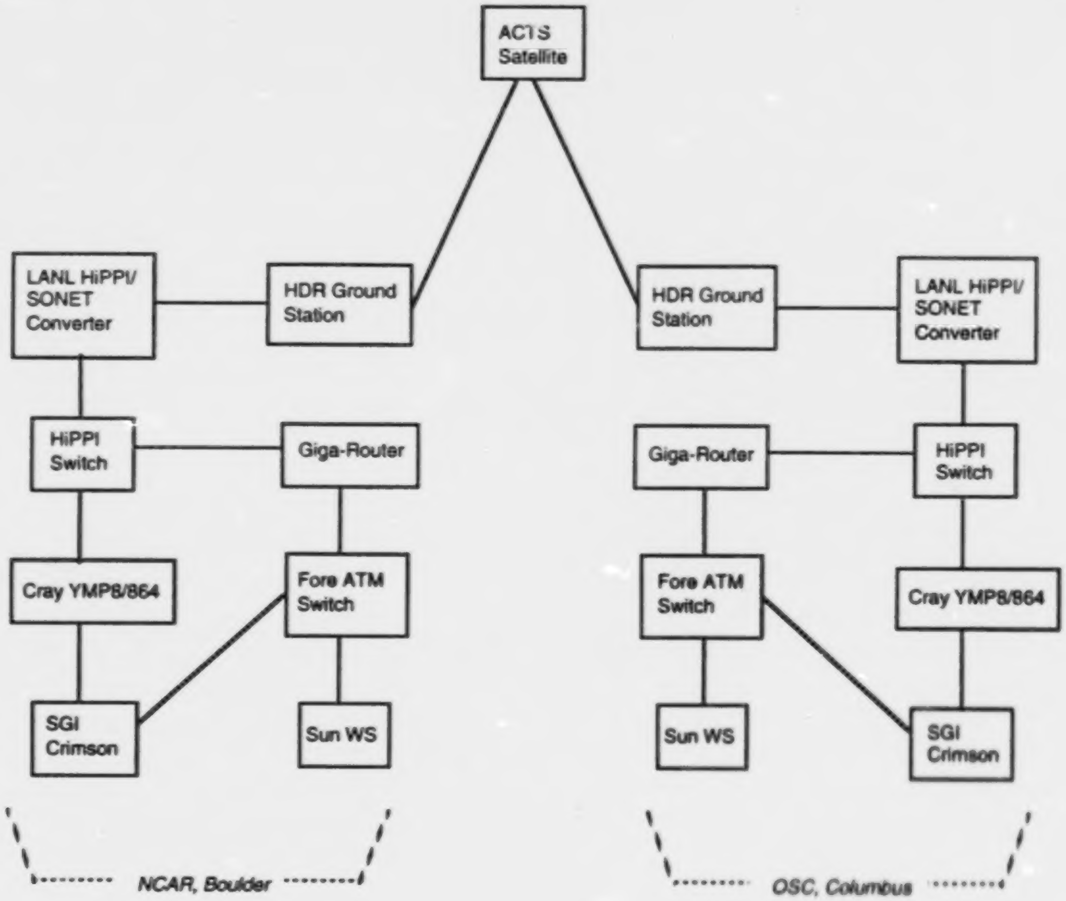

ACTS Satellite
LANL HiPPI/ SONET Converter
HDR Ground Station
HDR Ground Station
LANL HiPPI/ SONET Converter
HiPPI Switch
Giga-Router
Giga-Router
HiPPI Switch
Cray YMP8/864
Fore ATM Switch
Fore ATM Switch
Cray YMP8/864
SGI Crimson
Sun WS
Sun WS
SGI Crimson
NCAR, Boulder
OSC, Columbus

Figure 4: NCAR/OSC Experiment Hardware Configuration

6) Conclusions

NASA's goal is to demonstrate advanced space-based communications technologies, such as those which comprise ACTS, and how these technologies will play a key role in the development of a true Global Information Infrastructure. To this end, the ACTS Gigabit Satellite Network has demonstrated compatibility with high-speed terrestrial optical fiber service. This proof-of-concept allows conventional SONET service, as well as emerging services, such as ATM to be transmitted over broadband satellite systems. However, due to latencies associated with geostationary satellites, the communications protocols need to be modified (and potentially re-defined) to make more efficient use of these advanced schemes. Some ACTS experiments have investigated these protocol issues and have attempted to quantify the issue and examine alternative methods.

In the future, wideband satellites should play a significant role in complementing terrestrial fiber networks. This is especially true for applications in need of access to remote or mobile locations, underserviced regions, or added network agility. Besides the development and test of the Gigabit Satellite Network, and the two actual experiment field trials cited in this paper, the ACTS High Data Rate Experiments Program will continue to be executed throughout the life of the satellite. These program plans include an earth station in Hawaii and complete interconnection of two Gigabit testbed terrestrial networks.

References

[1] Schertler, R. J., Crisafulli, J., "NASA Advanced Communication Technology Satellite (ACTS) An On-orbit Testbed", Pacific Telecommunications Conference, January 22-26, 1995

[2] Bergamo, M. A., "Terminal System and Capability for ARPA-NASA High-Speed SONET/ATM Experiments Over NASA's Advanced Communications Technology Satellite", MILCOM '93, pg. 235-241.

[3] Bergamo, M. A., "Network Architecture and SONET Services in the NASA/ARPA Gigabit Satellite Network using NASA's Advanced Communications Technology Satellite (ACTS)", 15th AIAA International Communications Satellite Systems Conference, pp. 208-216, February 28-March 3, 1994.

[4] Bergamo, M. A, Hoder, D. J.,"Gigabit Satellite Network Using NASA's Advanced Communications Technology Satellite (ACTS): Features, Capabilities, and Operations", Pacific Telecommunications Conference, January 22-26, 1995

[5] Hoder, D., Kearney, B., "High Data-Rate Ground Station for the ACTS Gigabit Satellite Network (GSN)", NASA ACTS Results Conference, September 11-13, 1995

[6] Kearney, B. and Lee, K. "High Data Rate Modem for Support of ACTS Gigabit Network", 15th AIAA International Communications Satellite Systems Conference, February 28-March 3, 1994.

[7] Brooks, D. E., Carrozzi, T. M., Dowd, F. W., Lopez, I., Pellegrino, S. M., Srinidhi, S. M., "ATM Based Geographically Distributed Computing Over ACTS", ACTS Results Conference, September 11-13. 1995

[8] Carlson, W.E., Spencer, S. N., Geroch, M., Lewis, M., Bedford, K., Welsh, D., Kelley, J., Welch, A., "Visualization Of Results From A Distributed, Coupled, Supercomputer-Based Mesoscale Atmospheric And Lake Models Using The Nasa Acts", ACTS Results Conference, September 11-13. 1995

[9] personal communication with Jon C. Freeman

[10] Bellcore TR-NWT-000253, "Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria", Issue 2, December 1991.

[11] ANSI T1.105-1991, "Digital Hierarchy - Optical Interface Rates and Format Specifications (SONET)", July 2, 1991.

SHARING COMPUTATIONAL RESOURCES AND MEDICAL IMAGES VIA ACTS-LINKED NETWORKS

David Y. Y. Yun and H. M. Chen-Garcia
492 Holmes, 2540 Dole St.
Department of Electrical Engineering
University of Hawaii, Honolulu, HI, USA 96822

ABSTRACT

At the inception of the Information Society program by the G7 countries and the Global Information Infrastructure (GII), the interconnectivity of national terrestrial networks, already or to be connected by fiber optical cables, seems so complex and costly that must rely on integration by satellites. ACTS (Advanced Communication Technology Satellite), with its high powered Ka band, near giga-bit speed, and flexible steerable antenna capabilities, is increasingly recognized to play a critical role both in terms of its technology demonstration success and its network integration potential. Hawaii has made an early decision and investment in ACTS-related satellite communication technology by acquiring the High Data Rate (HDR) earth station to provide the necessary, on-demand, long-haul link for this remote but strategic Mid-Pacific location. Applications in medical image sharing, supercomputing and graphics networking, remote astronomical observation, and coordinated disaster management, demonstrate not only the unique advantages of Hawaii central location but also its potential in providing the essential link in the GII.

1. INTRODUCTION

ACTS (Advanced Communication Technology Satellite) provides a broad-band link in space, which is capable of serving as an alternative to ground based inter-network fiber-optic trunks. Such satellite communication also offer unique advantages, such as on-demand linkage and easy access to remote or mobile sites. These advantages are particularly important in life-critical medical services of teleradiology, distributed treatment planning and medical triage support applications. Hawaii is in a unique position to conduct validation experiments, when a tripartite agreement was executed among the State, ARPA, and NASA to acquire the only non-federal HDR (High Data Rate) earthstation. This paper reports on experiments designed to link supercomputer power (at the Ohio Supercomputer Center and the Maui High Performance Computer Center), 3D volumetric modeling technology (at OSC and University of Hawaii, Image Information Lab) and medical image data sharing (at Georgetown University Medical Center and Tripler Army Medical Center of Hawaii) to validate a suite of deployable digital radiology technologies for image-based cooperative medical triage as well as remote radiation treatment planning.

The success of the experiments will demonstrate that high speed (OC-3 ATM) satellite communication (particularly, ACTS) providing access (via the steerable antenna) to high performance computation and high resolution 3D visualization is both practical and crucial for many applications, especially in emergency medical or disaster relief situations for remote regions or moving populations. It will also validate the concept that high bandwidth communication will enable more effective sharing of centralized computing capabilities by remote sites (in this case, clinics), which can ill-afford the sophisticated hardware/software nor the support expertise, locally. This demonstration is expected to stimulate new medical services as well as delivery mechanisms that transcend both time and distance barriers. Even with the satellite latency problem, remote access to computation and visualization power will be shown to improve the turn-around time of certain applications by an order of magnitude. The availability of remote access to supercomputing via high-speed portable connections will have a profound impact on the provision of remote medical services and image-based delivery of health care

1.1 Satellite Networking

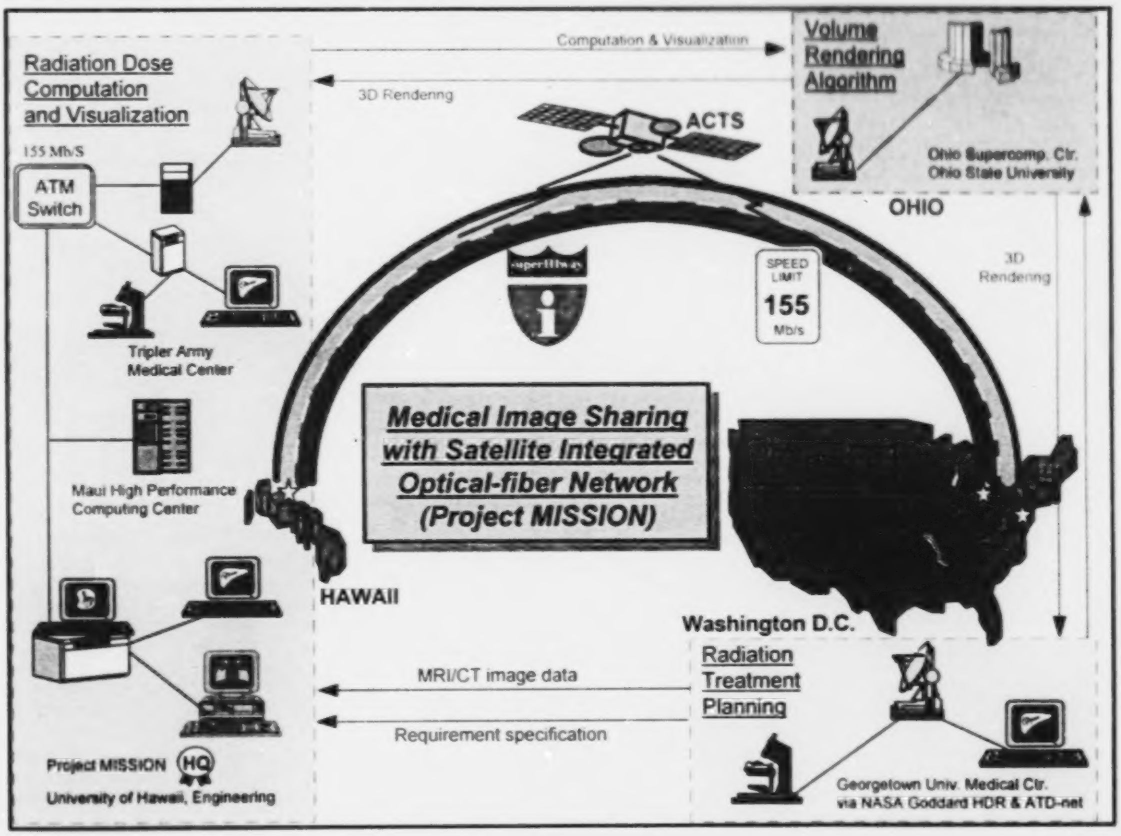
Recent rapid advances in multi-dimensional imaging and multimedia presentation technologies have opened unprecedented opportunities for innovative integration and distribution of medical services. This will create enormous demands on network bandwidth capacity and effective transfer rate for the access and utilization of image-based medical information. The launch of the National Information Infrastructure (NII) initiative in February of 1993 has accelerated the development of advanced communication technology together with the large-scale integration of diverse, heterogeneous imaging, computing and visualization capabilities. The successful development of these high performance networks will enable the delivery of novel image-based medical services transcending traditional barriers of time, geography, and available expertise. As an in-orbit testbed for new technologies and applications, NASA's ACTS was launched into orbit by the Space Shuttle DISCOVERY on Sept. 12, 1993 and achieved its intended geosynchronous station at 100° West longitude on Sept. 28, 1993 [10]. The Project MISSION (Medical Imaging Support via Satellite Integrated Optical-fiber Network), funded by ARPA (DoD's Advanced Research Project Agency) and coordinated at the University of Hawaii, is a feasibility study that experiments with the use of the ACTS gigabit satellite linkage combined with supercomputing and graphic visualization power to validate such novel medical applications as distributed radiation treatment planning and remote medical triage support.

1.2 Team Structure

Critical support to this project also comes from NASA (providing free ACTS time), the State of Hawaii (HDR acquisition and administrative assistance), and the Army's MDIS (Medical Diagnostic Information Support) program. Hawaii's Tripler Army Medical Center (TAMC) will not only be providing medical data and clinical expertise but also a home for the HDR earth station. As the hub of medical services in the Pacific and a key participant in the MDIS program, TAMC is a natural partner for Project MISSION. The scaleable supercomputer (a 400-processor IBM SP2 capable of 100 giga-FLOPS) funded by the Air Force and installed at Hawaii's Maui Research and Technology Park (MRTP) is also a natural partner to support the computational requirements of the experiments. Thus, TAMC and MRTP, led by the UH and linked with a fiber optic ATM network, become the Hawaii-based tripartite team that collectively and individually complements the satellite linked team of GUMC, OSC and UH in terms of both functionality and expertise.

1.3 Project Phases

This ARPA funded project, entitled "*ACTS and Supercomputing in Remote Cooperative Medical Triage Support and Radiation Treatment Planning,*" focuses on technology validating experiments designed to integrate the use of the supercomputer power, 3D volumetric modeling technology, and NASA's ACTS capability in order to validate the suite of deployable digital radiography technologies for image-based medical triage as well as remote cooperative delivery of health care. Succeeding these experiments demonstrates that high speed (giga-bit, Ka-band ACTS) satellite communication providing on-demand access (via the steerable antenna) to high performance computation and high resolution 3D


Radiation Dose Computation and Visualization
155 Mb/S
ATM Switch
Tripler Army Medical Center
Maui High Performance Computing Center
Project MISSION HQ
University of Hawaii, Engineering
HAWAII
Computation & Visualization
3D Rendenng
ACTS
Volume Rendering Algorithm
Ohio Supercomp. Ctr.
Ohio State University
OHIO
3D Rendenng
superHiway
i
SPEED LIMIT 155 Mb/s
Medical Image Sharing with Satellite Integrated Optical-fiber Network (Project MISSION)
Washington D.C.
Radiation Treatment Planning
MRI/CT image data
Requirement specification
Georgetown Univ. Medical Ctr. via NASA Goddard HDR & ATD-net

visualization that are not only practical but also crucial for many medical applications, especially for remote regions or moving populations (e.g. on ships). The demonstration should further stimulate new medical services as well as delivery mechanisms that transcend both time and distance barriers (suffered by such places as Hawaii and Alaska).

The successful demonstration of this distributed remote treatment planning experiment via the ACTS-HDR gigabit satellite network is expected to stimulate new medical services as well as delivery mechanisms that transcend time, distance, and resource barriers. The availability of remote access to supercomputing via high-speed portable connections will significantly impact existing medical services. The impact will not simply be technological but also economic and organizational when medical resources (data, personnel, hardware, software, equipment, etc.) can be shared by service-delivery personnel globally and dynamically.

Detailed requirements are defined in technical, clinical and communication aspects of the imaging-based (disaster relief) deployable medical systems. Experiments using the supercomputer volumetric modeling power and ACTS communication bandwidth will be conducted to test the deployable digital radiography technologies for image-based medical triage and remote, cooperative delivery of health care. In addition, it will be demonstrated that high speed communication (i.e., ACTS-HDR) is not only practical but also crucial for the medical applications.

The project focuses on the following important medical applications that entail high-speed telecommunications: teleradiology, treatment planning and medical triage support.

- **Teleradiology**: Diagnostic radiology generally processes a large volume of image data. The traditional way of handling these data is to have them on films. The diagnostic capability is greatly limited by the limited number of films, the limited views on films, and especially the limited local access to the films. High speed telecommunication provides a bright future for diagnostic radiology in that it first allows the remotely located experts to analyze the patient situation and secondly allows the experts to view the images in unlimited perspectives (digitally reconstructed images as opposed to images on films).
- **Radiation Treatment Planning**: Radiation treatment has been the main treatment for cancer for decades. The idea behind radiation therapy is to deliver a tumorcidal dose of radiation to a tumor volume while minimizing doses to surrounding normal tissues. The results of treatments greatly depend on the planning. Conventionally, treatment planning is performed on 2D slices of CT images. This is not only inaccurate but also unable to restrict radiation dosage to the desired region. 3D conformal treatment planning has emerged just recently. It is accurate due to the full consideration of the three dimensional structures of a patient's anatomy. Furthermore, by planning 3D beams (as opposed to co-planer beams in the 2D planning) we can expect to deliver doses conformally on the tumor. However, 3D planning is currently very limited due to the limited access to powerful computers. The requirements of computers for 3D planning are in two aspects: 3D graphics and computation. It requires a high performance 3D graphics computer to allow physicians to view the anatomy, draw beams and evaluate dose distributions. It requires a high speed CPU to compute and even optimize dose distributions based on the beam and anatomy information. High speed communication provides a solution. Through high speed communication, dose computation and high quality graphics such as volume rendering or volume rendering with dose distribution can be performed on supercomputers at remote sites.
- **Medical Triage Support**: High speed communication is needed for the delivery of medical expertise for consultation in triage with remote based non-expert personnel located in a disaster area (or disadvantaged regions or war zones). In triage situations, it is important to have rapid access to vital information about the injured. Rapid imaging and reconstruction of the acquired data will enable a better assessment of the injuries. In addition, workload sharing between hospitals and high-cost medical imaging and supercomputing facilities can only be made possible through high-speed communication.

In the next section, the applications (i.e., teleradiology and distributed remote treatment planning) designed for this experiment will be described. In Section 3, we provide some background on ACTS-HDR to make clear its crucial advantages for medical applications. In Section 4, we present the experimental design. In Section 5, we discuss research and development associated with this experiment, including CADx, 3D volume rendering techniques and image management. Section 6 concludes this paper with remarks on the current status of the project and the implications of this experiment on PACS (Picture Archiving and Communication Systems).

2. REMOTE IMAGE-BASED MEDICAL SERVICE

Many important medical applications entail high-speed telecommunications for efficient transfer of medical image information, a critical aspect of PACS. Historically, PACS evolved from teleradiology application. A typical application of teleradiology is to transmit images of trauma cases from one site to another. The multimedia interactive conferencing capability is now being utilized in teleradiology to enables cooperation with remotely located experts to interactively analyze a patient's situation by viewing the images in various perspectives. In triage situations, it is important to have rapid access to vital information about the injured. Rapid imaging and reconstruction of the acquired data will enable a better assessment of injuries. As image data are volumous, the effectiveness of diagnostic capability depends on adequate network bandwidth and computing power. The issues of costly computer power could be lessened with a high capability network in place so that expensive advanced medical imaging facilities and graphics workstations can be shared among different hospitals. This way, workload sharing among hospitals as well as delivery of medical expertise for consultation in triage with remote based non-expert personnel located in a disaster area (or disadvantaged regions or war zones) can be made possible.

The medical service selected for Project MISSION is the distributed remote treatment planning section. Radiation treatment planning is an ideal application for validating the usage of high speed networks in cooperative medicine due to the scarcity of oncology expertise, the complexity of optimization procedures and its requirement of high-speed computing power and communication bandwidth for volume visualization. Radiation therapy has been the main treatment for cancer for decades. The idea behind radiation therapy is to deliver a tumorcidal dose of radiation to a tumor volume while minimizing doses to surrounding normal tissues. The results of the treatments depend greatly on the planning. In order to administer tumorcidal doses to deep-seated tumors, it is necessary for the radiation to be cross-fired from a number of different angles which are aligned to intersect inside the tumor. Treatment planning is the process developed to assure that these beams indeed intersected inside the tumor and avoid irradiating critical normal tissues such as the spinal cord or kidney.

Conventional treatment planning is performed on 2D slices of CT images. This is not only inaccurate but is also incapable of restricting radiation dosage to the desired region. 3D conformal treatment planning has emerged just recently. It is accurate due to the full consideration of the three dimensional structure of a patient's anatomy. Furthermore, by planning 3D beams (as opposed to co-planer beams in the 2D planning) we can expect to deliver doses conformally on the tumor. However, 3D planning is currently very restricted due to the limited access to powerful computers. The requirements for computers in 3D planning consist of two aspects: 3D graphics and computation. It requires a high performance 3D graphics computer to allow physicians to view the anatomy, draw beams and evaluate dose distributions. It then requires a high speed CPU to compute and even optimize dose distributions based on the beam and anatomy information. The ideal goal, clinically, is for the computations to be near real time so that the iterative optimization can be efficiently executed. A solution is provided by high speed communication, through which dosage computation and high quality graphics visualization, such as volume rendering or dose distribution, can be performed by remote computational resources and transmitted seamlessly back to the users.

3. GIGABIT SATELLITE NETWORK

Although satellite communication may suffer from such comparative weaknesses as transmission latency, medium stability, and bandwidth capacity, several advantages over fiber-based communication should be stressed especially on-demand linkage and easy access to remote or mobile sites. Most importantly, satellites can provide connectivity to any part of the world no matter how remote and to highly mobile people (such as island nations, ships, or troops) no matter what surrounding, so long as a ground terminal can be made available. In some cases, satellite linkage may be the only means of providing telecommunication services. Since medical services may be required any where and any time, satellite communication can be a critical link to these remote /disadvantaged areas or mobile populations.

Satellite communication has matured from the initial stage of bent pipe operations through the stage of multiple beams and switch routing to begin a new stage, where scan beams are synchronized with on-board routing and processing. ACTS is pioneering the key technologies required for the ground control of on-orbit switching that can dramatically enhance the capabilities of communication satellites. Specifically, ACTS embodies essential advanced communication technologies to rival ground fiber networking, including:

1) *high gain, hopping, spot beams* - A rapidly reconfigurable pattern of narrow hopping and fixed spot beams. The high gain antenna used to produce the spot beams enables communications with small, low cost earth stations;
2) *on-orbit switching* - A high speed, digital processor on-board the satellite which routes individual circuits to provide single hop mesh interconnectivity. This single hop interconnectivity is in contrast to today's VSAT systems, which require a double hop employing a central hub ground station.
3) *Ka-band, wide bandwidth transponders* - Use of the Ka-band opens up a new portion of the radio frequency spectrum. The bandwidth allocation for Ka-band use by communication satellites is 2.5 GHz.

HDR (High Data Rate) is an earth station jointly developed by NASA and ARPA to exploit the wide bandwidth (900

MHz) capabilities of ACTS. Employing a 3.5 m antenna, the HDR earth station provides multiple OC-3 (155.52 Mbps) or a single OC-12 (622.08 Mbps) interconnections for point-to-point or point-to-multipoint operations. These earth stations have full duplex capability using satellite switch TDMA and accommodate the SONET protocols.

These technologies provide for a flexible communications network that delivers voice, data, video and multimedia services on-demand. User service costs should be lower as the user will only be charged for the time period actually used. ACTS services are designed for seamless interconnection into the terrestrial network. In addition the ACTS network has the capability to provide both ISDN and SONET transmissions. The architecture of the Gigabit Satellite Network is composed of a transportable Gigabit Earth Stations (GES), such as a HDR or a tried-and-true T1/VSAT, with fiber-optic SONET interfaces, that communicate directly over satellite using the antenna beams and the on-board uplink-to-downlink beam switching capabilities of ACTS. The network control and management functions are distributed in the various GESs with the operator's interface being centralized in a Network Management Terminal (NMT). The NMT can be located at any GES site or, alternatively, at any location with terrestrial Internet connectivity to a GES designated as a reference station. The end user services of this network are configurable point-to-point or point-to-multipoint 155 Mb/s and 622 Mb/s SONET "links" over satellite. The network control and management functions make use of the standard SNMP protocol and are accessible from the Network Management Terminal. Authorized operators can also access certain network control and management functions from console interfaces local to the GES or remotely through the Internet and dial-up modems.

Transmissions to the satellite are performed using Satellite-Switched Time Division Multiple Access (SS-TDMA) techniques with on-board space-time-space switching being performed by the High-Data-Rate section of the ACTS Multibeam Communications Package. Up to three uplink and three downlink antenna beams can be active simultaneously, that combined with 696 Mb/s burst rates per antenna beam, results in an aggregate system bit rate in excess of 2 Gb/s. Forward Error Correction (FEC) and overhead functions use approximately 10% of the total system bandwidth, resulting in end-user aggregate throughput in excess of 1.8 Gb/s (3 x OC-12).

4. EXPERIMENTAL DESIGN

The experiment is designed to be conducted in a phased manner to demonstrate the feasibility of using ACTS communication for supporting the afore-mentioned medical services. Phase 1 (Teleradiology Experiments via Internet) and Phase 2 (Teleradiology and two-way treatment planning via ACTS-HDR) experiments set the stage for the final-phase experiments (Three-way medical triage & remote treatment planning).

4.1 (Phase 1) Teleradiology Experiment and Computer-aided Diagnosis

The objective of the first-phase teleradiology experiment will use the Internet to transmit images. This will be compared to a T1-VSAT connection, thereby setting up the communication infrastructure and beginning remote radiology support. This will also serve as a comparison with the teleradiology service via ACTS-HDR.

Chest images (X-ray or CR) (resolution varying from 2Kx2.5K x 10 to 2k x 2.5 K x 12 or higher) will be transmitted From TAMC MDIS network to be read at Georgetown. Radiologists at Georgetown will then return the diagnostic reports and perhaps do overlays (marks) on the images. The image volume will be scaled up gradually and this will serve as a comparison for the next step, which is teleradiology service via ACTS-HDR. Operational aspects and the clinical efficacy of such service will be studied through actual measurements as well as small focused sessions at the sites.

4.2 (Phase 2) Two-way Treatment planning Via ACTS

The objective of the Phase 2 experiment is to test and set up the ACTS and begin remote treatment planning utilizing supercomputing power. For each simulation the GU will collect and preprocess (e.g., outline organs and target volume to be treated) a CT image data set and use the virtual simulation code PLUNC to determine an accelerator gantry/beam configuration. This data will be forwarded by ACTS-HDR transmission to OSC for dose computation and image rendering. The processed data including the dose matrix will then be transmitted back to GU for interactive display and additional processing. The rendered plan is to be evaluated by a physician for biological/medical factors and a display of locally computed dose-volume histograms. Following this evaluation process a new beam configuration will be requested and the process reinitiated.

4.3. (Phase 3) Distributed Radiation Treatment Planning, Optimization and Visualization

The final phase experiment will perform remote treatment planning via ACTS HDR among the three principal sites. The goal here are to demonstrate that with high speed data communication, radiation treatment planning can be performed in parallel on several remotely located supercomputers. The data flow is as shown (see Figure 2). Initially, a set of medical image data from an MRI or CT scanner is sent to OH where the image data is stored and 3D volume is reconstructed and rendered. This volume rendered is sent to GUMC. GUMC uses the volume rendered for an initial configuration of the dose computation (beam configuration) which is sent to UH. Based upon the configuration from GUMC and scanner data, dose computation software is executed on a supercomputer at UH. The results of the dose computation (a grid which comprises the primary data channel in terms of bandwidth) are sent to OSC where it is "fused" with the original scanner data and a visualization of both (scanner data & dose computation results) is performed on an SGI high-performance workstation. The visualization, in video image form, is sent to GUMC for evaluation. After analysis of the visualization by radiologists at GUMC, the dose configuration is refined and sent to UH for another iteration of the dose computation/visualization sequence. While the dose computation is being calculated, radiologists at GUMC may manipulate the visualization from the previous iteration by sending new visualization specifications (orientation, color/opacity maps, cutting planes, etc.) to OSC where it is immediately re-visualized and the resulting images are sent back to GUMC. Manipulation of the visualization is asynchronous with the dose computation being concurrently performed at UH.

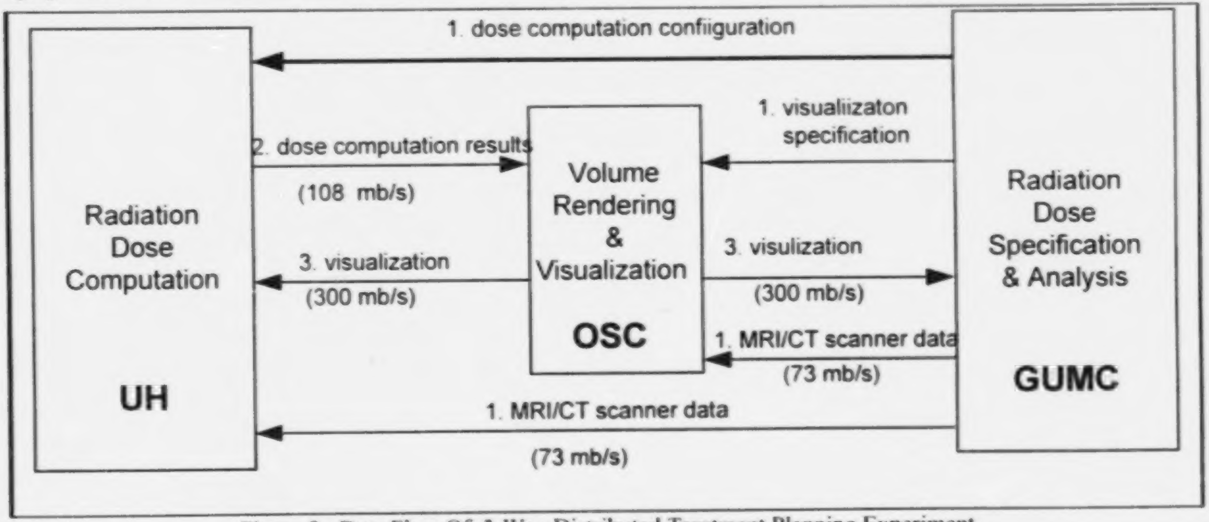


Figure 2. Data Flow Of 3-Way Distributed Treatment Planning Experiment

The following calculates the bandwidth requirements for the three steps of the remote treatment planning.

Step 1. Sending a image volume from GUMC to OSC.

The data set normally contains 50-100 slices of 512x512 images, each of which has 12 bits of gray scale. The average size of this data set is approximately: $75 \times 512^2 \times 12 = 219$ Mbits. It would be unreasonable for this transmit to be more than a few seconds. The bandwidth required at this step can be 219/2 = 109.5 Mbps or 219 / 3 = 73 Mbps. OC-3 will be sufficient for handling this transmission in 2 seconds.

Step 2. Sending dose matrices from UH to OSC

During dose computation, some intermediate results need to be constantly transferred from one computer to another in order to obtain an integrated final result. The massive data set at this point is the dose matrices, each of which generally has 150^3 of 64-bit points (minimal). The size of the data is then about $150^3 \times 8 \times 8 = 216$ Mbits. The frequency of this depends on the speed of the computers that perform dose computations, but generally speaking, it can be once every two seconds. The bandwidth required at this step is at least 108 Mbps.

Step 3: Constantly sending screen images (rendered volume) from OSC to UH as well as GUMC

Once the dose computation is finished, the dose distribution needs to be displayed and verified by physicians and physicists. The best way is to perform interactive volume rendering with dose distributions superimposed. Interactive volume rendering is only possible on supercomputers and hence we need to perform it remotely and constantly receive data back. This requires us to receive 512 x 512 of 24 bit (total 6 Mbits) images at the frequency of at least 50 times per second. The bandwidth required is at least 300 Mbps.

To conclude the three steps of operations discussed above, we require a bandwidth of at least 300 Mbps, as indicated in the last operation. A lower bandwidth will inhibit the smooth interactive animation as constantly sending screen images become flickering and stepping. In this sense, a connection with OC-6 or higher is definitely more desirable although OC-3 could be acceptable.

The success of the experiment depends on smooth reliable network connectivity and successful development of software required for teleradiology and radiation treatment planning. The necessary SGI workstations with FDDI and ATM interfaces have been acquired. GTE Hawaiian Tel will provide the ATM switches with OC-3 capability connecting UH, TAMC and MHPCC for the Hawaii fiber-based network connectivity. TAMC already has an image storage and management system for the MDIS network funded by the US ARMY. The development of CADx, volume render and segmentation algorithm is an integral part of Project MISSION and will be describe in the following section.

5. RELATED ACTIVITIES

Many research and development activities are critical for carrying out the experiment, particularly, the development of computer-assisted diagnosis (CADx), volume render and segmentation algorithm. We are not only preparing to conduct successful experiments via ACT-HDR but also to make the research results beneficial to the medical fields. As a result, the image management (storage, retrieval and manipulation) problem, closely related to image communication problems for effective medical triage support, is also being investigated. We summarize below our effort in these three areas.

5.1 CAD of Lung Nodule using Convolution ANN

The goal of this task is to enhance the detection of small pulmonary nodules by computer-assisted diagnosis (CADx). CADx is an important way for improving diagnostic effectiveness. As shown in an experiment, even with highly skilled and highly motivated radiologists, task-directed to detect any suspicious finding for a pulmonary nodule, and working with high quality chest radiographs, only 68% of all retrospectively detected lung cancers were detected prospectively when read by one reader, and only 82% were detected by two readers.

5.2 3D Volume Visualization

The ability of a radiologist to visualize radiation dose distribution in 3D solid model (or volume) for treatment planning is critical to the success of the therapy. In addition to testing an upgraded version of the 3D treatment planning code PLUNC, developed at the University of North Carolina (UNC) at Chapel Hill, the goal of the task is to develop specifications for all aspects of a 3D volume rendering program, to design the network protocol and the user interface, and to examine several directions for achieving rendering speedup. Three aspects are being investigated: parallel and distributed volume rendering, template-based volume viewing, and efficient segmentation and volume fusion.

5.3 Intelligent Medical Image Management

The integrated management of medical images (image retrieval as well as image communications) is critical for delivering timely and effective patient care. Even though high-performance communication is available, access and retrieval of images still requires new innovations. A distributed, knowledge-based approach to store and retrieve image data is expected to speed up the retrieval response time. We have designed a system architecture to guide our continued MISSION-DBS (database system) research effort and developed a poly-paradigmic approach to image retrieval (see [1]). In parallel, we have developed a holographic content-based image retrieval mechanism as well as parallel image processing tools, discussed as follows:

5.3.1 Holographic Content-Based Search

A holographic mechanism enfolds the images of a typical database into a concise holograph. A holograph can be considered a visual abstract of a collection of images (still/video). Not only has this relatively new associative memory model demonstrated distinctively superior convergence and capacity characteristics over the conventional neural network based approaches (Hopfield, BAM, fuzzy-ART, etc.), but also it can support focused search by dynamically controllable match of a part (as small as only 10%) of the desired image. This new associative memory mechanism will be developed into an intelligent system to perform content-based image retrieval. A holographic search is very fast compared to a conventional search. It automatically contains statistical summary of images. Moreover, a large number of images can be summarized inside a single holograph. Also, abstracts can be updated incrementally. The search can be performed on the basis of whole or any part of the frame field. Thus, a query is extremely flexible; the process is fully automatic; and the method is linearly scaleable with the image frame sizes (see [2] and [3]).

5.3.2 Parallel Image Processing Tools

Our goal is to develop efficient approaches for feature extraction and exploring the underlying image structures in order to further advance the technology of image processing. First, a real-time adaptive image compression technique using competitive learning (neural networks) NNs is developed and implemented for massively parallel computing systems. With the experience in adaptive vector quantization (VQ), using an NN model to find the maximum in constant time, and mapping of various NN models for a transputer system, significant speed-up and scale-up are expected to meet the needs of real-time video and image compression. In addition, a parallelization processes will be developed that maps the adaptive VQ algorithm to scale up and achieve optimal performance. Second, as parallel processors have emerged as practical computing engines for many image processing tasks, we will exploit the state-of-the-art parallel processing technology focusing on 1) fast parallel algorithms for components labeling; and 2) parallel processing of 3D treatment planning code (PLUNC).

6. CONCLUSION

High speed portable communications will enable 1) effective remote medical consultation or collaborative decision-making using shared medical image data, 2) delivery of timely medical expertise for image-based triage consultation to remote areas or mobile populations (e.g. disadvantaged regions, ships or war zones), and 3) operational efficiency due to the accessibility and employment of powerful supercomputers or visualization capabilities. The objective of Project MISSION is to integrate the necessary technologies and demonstrate the feasibility/importance of satellite communications in the timely delivery of life-critical medical service. The Project has completed all the requirements of Phase 1 and has completed the necessary network deployment and software development for Phase 2. The successful demonstration of this distributed remote treatment planning experiment via the ACTS-HDR gigabit satellite network is expected to stimulate new medical services as well as delivery mechanisms that transcend time, distance, and resource barriers. The availability of remote access to supercomputing via high-speed portable connections will significantly impact existing medical services. The implications for PACS will not simply be technological but also economic and organizational when medical resources (data, personnel, hardware, software, equipment, etc.) can be shared by service-delivery personnel globally and dynamically.

7. ACKNOWLEDGMENT

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References

1. Garcia, Hong-Mei Chen and Yun, D. Y. Y., "Intelligent Distributed Medical Image Management." *SPIE Medical Imaging 1995*.
2. Khan, Javed I. and Yun, D. Y. Y., "Chaotic Vectors and a proposal for multidimensional associative network." *Proceedings IS&T/SPIE Electronic Imaging: Science & Technology*, Feb. 6-10, 1994, San Jose, CA
3. Khan, J. I. and Yun D. Y. Y., "Feature-based Contraction of Sparse Holographic Associative Memory." *Proceedings World Congress on Neural Networks*, San Diego, June 5-9, 1994, pp. IV-26-34.
4. Lo, S.C., Freedman, M.T., Krasner, B.H., Mun, S.K., "Automatic Lung Nodule Detection Using Profile Matching and Back-Propagation Neural Network Techniques" *Journal of Digital Imaging*, Vol. 6, No. 1, 1993, pp. 48-54.
5. Schertler, Ronald J. and Crisafulli, Jim, "NASA Advanced Communication Technology Satellite (ACTS), An Orbit Testbed," *in Proceedings of Pacific Telemedicine Conference*, Honolulu, Hawaii, Jan. 22-26, 1995.
6. Tohme WG, Mun SK, Rodgers JE, Jia DX, "Evaluating the Need for Gigabit Speed Wide-Area Networks in Remote Medical Treatment", SPIE: PACS Design & Evaluation, accepted, San Diego, February 1995.
7. Tohme WG, Collmann JR, Mun SK, "Developing an Analytic Framework in the Assessment of Telemedicine", European Symposium on Advanced Networks and Services, accepted, Amsterdam, March 1995.

REMOTE HIGH DEFINITION VIDEO POST-PRODUCTION OVER A HIGH DATA RATE SATELLITE: The U.S. Network Architecture

Larry A. Bergman
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California 91109 USA

Burt Edelson and Neil Helm
George Washington University
Washington, D.C. 20052 USA

James Pearman and Richard West
Sony Pictures High Definition Center
Culver City, California 90232 USA

Frank Gargione
Lockheed Martin Astro Space
Princeton, New Jersey 08543 USA

1. ABSTRACT

This paper describes the U.S. plans for a Trans-Pacific High Data Rate Satellite Communications Experiment using the Advanced Communications Technology Satellite (ACTS) and INTELSAT to connect the U.S. and Japan at rates up to 155 Mbit/s (* The Japan plans are described in a companion paper at PTC'96) The experiment is one of the activities arising from the Japan–U.S. Cooperation in Space Project, and will link the U.S. mainland to Hawaii using ACTS and Hawaii to Japan using INTELSAT. The purpose of the experiment is to demonstrate that satellites can deliver digital image traffic at data rates and quality comparable to fiber optic cable. The data used for these experiments will consist mainly of High Definition Video (HDV) transmitted from the Sony Pictures High Definition Center in Los Angeles to Sony facilities in Tokyo. This experiment will provide quality high rate communication channels for the rapid transfer of HDV masters from the remote shooting locations around the world to post production facilities for editing, dubbing, distribution, etc.

2. INTRODUCTION

High data rate satellites, such as the recently launched NASA Advanced Communications Technology Satellite (ACTS), now offer the capability of transmitting near real-time high definition video (HDV) between all-digital HDV studios or directly to the home. This opens up a range of new applications in virtually all aspects of TV and motion picture production:

Pre-Production:

- Distributed location image data bases
- Enhanced workstation story boarding with real still images

Production:

- Rapid transmission of dailies back to studio from on-location

Post-Production:

- Distributed film/HDV post-production
- On-demand connection of studio to special effects houses

Distribution:

- Multi-cast HDV transmission to theatre or home

Of particular interest are HDV application domains where fiber optics is not likely to complete with satellites, e.g., those that either require multi-destination capability or high mobility or reach into areas where the population density does not justify fiber cable deployment. Two applications that meet this requirement are the *Production* and *Post-Production* phases of movie making (mainly because of the need for mobility). In fact, such capability also raises the possibility that these typically sequential phases of the production process may possibly be conducted in progressively more parallel fashion. This will likely shorten the overall time for movies to reach market at reduced cost while giving directors and actors more creative freedom by virtue of the instantaneous feedback on how their work will appear in the finished product.

This concept proposal describes a prototype *Remote HDV Post-Production* experiment utilizing the NASA ACTS high data rate satellite and the west-Pacific Intelsat satellite. The experimental concept represents an outgrowth

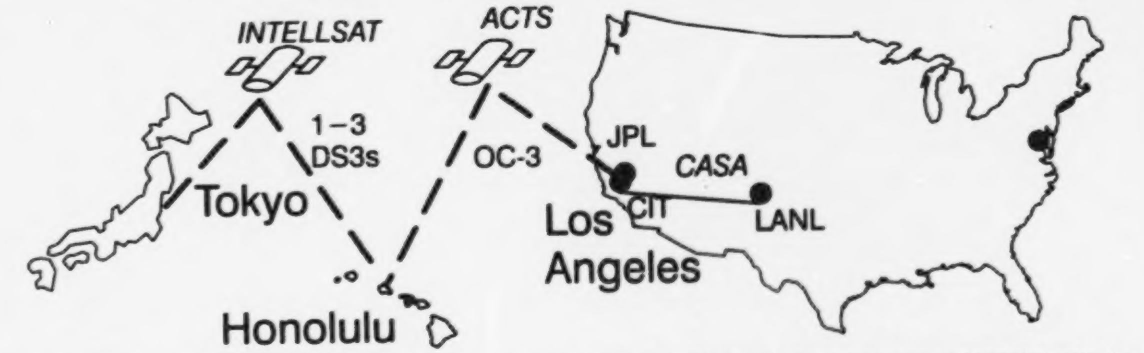

Fig. 1. The global communications network consists of two satellite hops: Los Angeles to Honolulu via the NASA ACTS, and Honolulu to Tokyo via Intellsat. At each of the three sites, local fiber optic SONET OC-3 tail circuits are provided by local carriers. In Los Angeles, connectivity to the CASA gigabit network also exists providing high speed access supercomputers to possible image processing.

of discussions of the Japan–U.S. Cooperation in Space Project Conference held on Maui, HI, Nov 11–14, 1993.

3. OBJECTIVES

The principal objectives of this experiment will be to: (1) demonstrate distributed (between all-digital HDV studios) and remote (from studio to location) HDV post-production using high data rate satellites, and (2) determine effects of latency, bit error rate, capacity on production throughput and degree of interactiveness. The results will guide the design, development, and applications of future commercial high data rate satellites.

4. APPROACH

The proposed experiment (see Fig. 1) consists of interconnecting Sony HDV post-production facilities located at Culver City, CA, and Tokyo, Japan, via the NASA ACTS satellite (from Los Angeles to Honolulu) and Intelsat satellite (from Honolulu to Tokyo). Nominal transmission rates will range from DS3 (45 Mbit/s) to SONET OC-3 (155 Mbit/s). Since uncompressed HDV requires 1.2 Gbit/s, real-time transmission will require lossy compression which will be suitable only for viewing but not recording masters. Non real-time transmission with full bit error detection/correction coding will be required for transmission of masters (x0.13 for uncompressed and x0.26 using lossless compression).

5. APPLICATIONS

The two video post-production applications that will be explored in this experiment will be: (1) real-time digital editing of remotely shot dailies for interactive playback, and (2) real-time interactive mixing of special effects (created on demand remotely) with live action footage.

5.1 Real-Time Digital Editing of Remotely Shot Dailies

With digital editing, it is now possible to experiment with far many more cuts to a film than was feasible with the traditional film-based Moviola. Additionally, since all the scenes have been transcribed (or digitized), it is extremely easy to transmit or import them to/from remote sites. This forms the basis of this experiment: to permit the director shooting on-location to be able to work closely with an editor in almost real-time, i.e., shoot a live action scene, digitize it (if not already), transmit it back to the studio for insertion into the finished master, and then instantaneously play it back to the director on-location for review. In this case, transmission back to the studio can proceed at full (un-compressed) resolution (albeit in slightly non-real-time) to maintain the highest quality master, while playback in the reverse direction can take place in either real-time (compressed, lower resolution mode) or non-real-time (uncompressed, higher resolution mode). A variation of this application could include positioning the film editor on-location (with the director) to remotely control the assembly of the film at the studio as live action footage it is shot.

5.2 *Real-time Interactive Mixing Of Special Effects (Created Remotely On Demand) With Live Action Footage*

Traditionally, special effects have always been produced separately from the live action footage and integrated late in the post-production process. Digital special effects, such as those in *Jurassic Park*, have now reached the level of sophistication where effects can be produced interactively (at least in wire frame) to suit the particular layout of live action in a scene. With the availability of massively parallel supercomputers and high speed communication links, this process can be considerably shortened and enhanced so that the same capability can be achieved with fully rendered images that can be transferred to masters. By actually creating effects at virtually the same rate as live footage is shot will considerably shorten production time while giving the director and actors more artistic freedom (more takes with fewer misses). Back at the studio, the effects might be generated on custom video effects equipment, high-end workstations, or even on-line supercomputers (such as the IBM SP-2 at the Maui High Performance Computing Center, the Cray T3D at JPL, or the Intel Delta at Caltech). This experiment will focus specifically on performing color correction, dissolves, and titling remotely.

6. ARCHITECTURE

6.1 Global Network

As shown in Fig. 2, the experiment network architecture will consist of four satellite high data rate (HDR) ground stations, tentatively located at JPL (Pasadena, CA), Tripler Army Medical Center (Honolulu, HI), and in/near Sony HQ (Tokyo, Japan). The JPL ACTS HDR ground station will be connected to the Culver City Sony HDV Studio with a 20 mile SONET OC-3 link provided by the Pacific Bell CalRENs program (could also be muliple DS3's). This

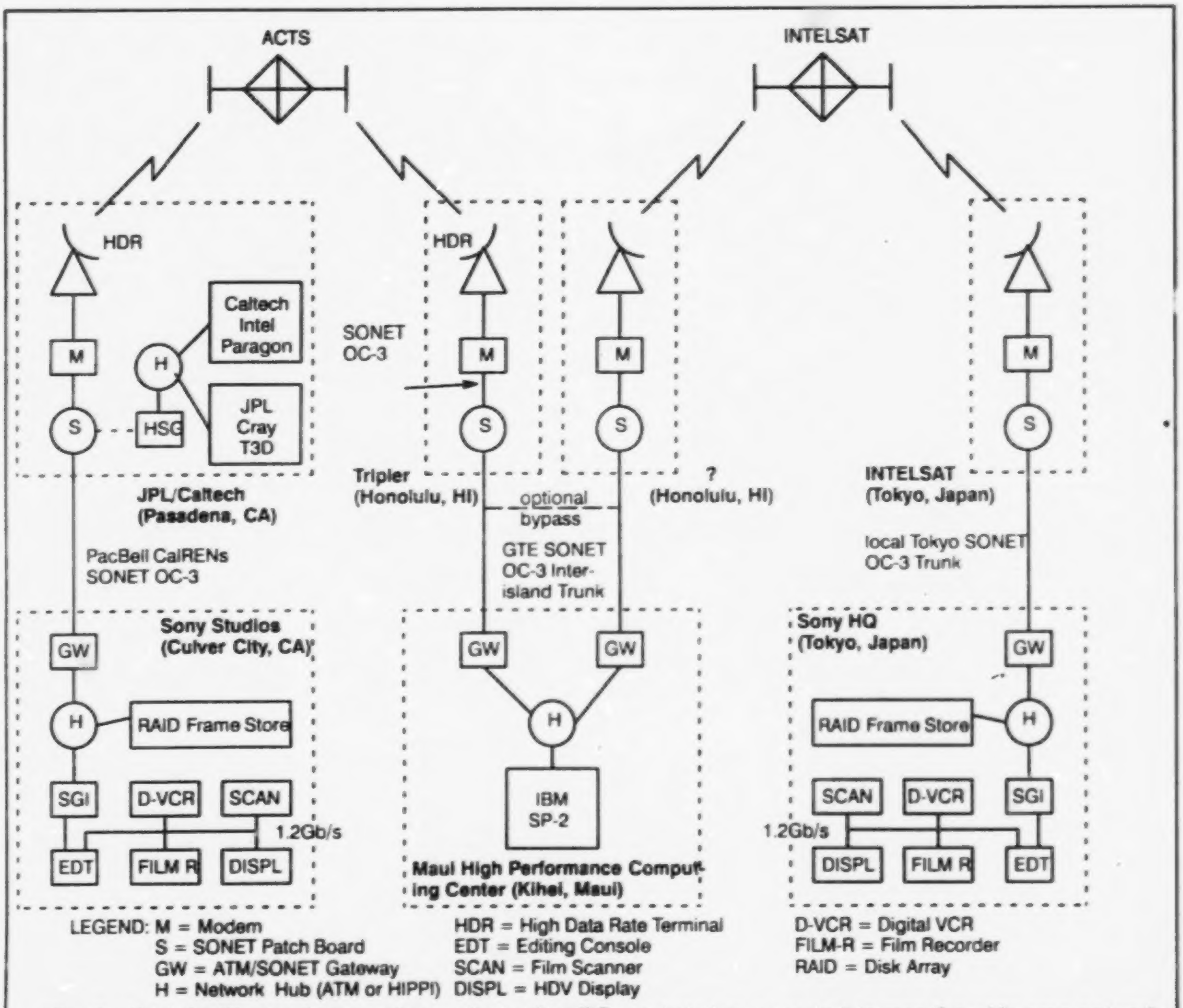
ACTS
INTELSAT
HDR
HDR
Caltech Intel Paragon
JPL Cray T3D
M
H
S
HSG
SONET OC-3
JPL/Caltech (Pasadena, CA)
Tripler (Honolulu, HI)
optional bypass
?
(Honolulu, HI)
INTELSAT (Tokyo, Japan)
PacBell CalRENs SONET OC-3
GTE SONET OC-3 Inter-island Trunk
local Tokyo SONET OC-3 Trunk
Sony Studios (Culver City, CA)
Sony HQ (Tokyo, Japan)
GW
RAID Frame Store
SGI
D-VCR
SCAN
EDT
FILM R
DISPL
1.2Gb/s
IBM SP-2
Maui High Performance Computing Center (Kihei, Maui)
LEGEND: M = Modem
S = SONET Patch Board
GW = ATM/SONET Gateway
H = Network Hub (ATM or HIPPI)
HDR = High Data Rate Terminal
EDT = Editing Console
SCAN = Film Scanner
DISPL = HDV Display
D-VCR = Digital VCR
FILM-R = Film Recorder
RAID = Disk Array

Fig. 2. Each facility employs a gateway (typically a PC, workstation, or router) to map the wide area network ATM/SONET fabric to the local area network (typically ethernet, FDDI, or HIPPI). The gateway provides the flexibility to connect to a variety of devices at different speeds.

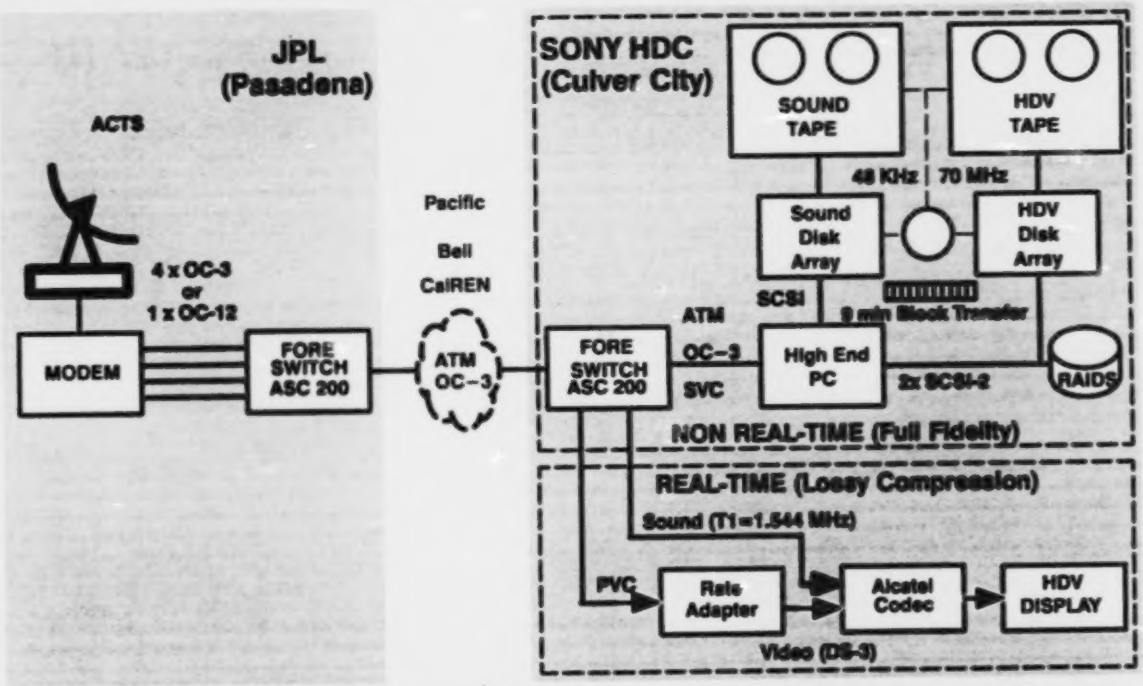
JPL
(Pasadena)
ACTS
4 x OC-3
or
1 x OC-12
MODEM
FORE
SWITCH
ASC 200
Pacific
Bell
CalREN
ATM
OC-3
SONY HDC
(Culver City)
SOUND
TAPE
HDV
TAPE
48 KHz
70 MHz
Sound
Disk
Array
HDV
Disk
Array
SCSI
9 min Block Transfer
ATM
OC-3
SVC
FORE
SWITCH
ASC 200
High End
PC
2x SCSI-2
RAIDS
NON REAL-TIME (Full Fidelity)
REAL-TIME (Lossy Compression)
Sound (T1=1.544 MHz)
PVC
Rate
Adapter
Alcatel
Codec
HDV
DISPLAY
Video (DS-3)

Fig. 3. The SONY High Definition Center consists of two post-production chains, one for non real time transfer of masters, and one for real–time quick look display of images (the latter using lossy compression). The non-real time chain is further divided two ways: one for high definition video and one for audio. Both are provided data via a gateway device (e.g., a high end PC) that translates ATM traffic to SCSI for delivery to large hard disk caches. The Pacific Bell CalREN ATM/OC-3 service provides connectivity to the JPL ACTS HDR.

HDR can optionally be moved to Culver City if needed. In Honolulu, the ACTS HDR will be located at Tripler Army Medical Center (TAMC) with SONET land connections to the Japan Intelsat ground station provided by Hawaiian Telephone. Additional terrestrial undersea fiber optic connections may be extended from TAMC on Oahu to Kihei, Maui, where the Maui High Performance Computing Center will be located. In Tokyo, the Sony Post-production facilities will be connected by local and long haul carriers to the nearest Intelsat ground station. The network connection at each post-production facility will be an SGI workstation configured with a HIPPI interface. A HIPPI/SONET gateway will tentatively be used at the end points until SONET/ATM OC-3 interfaces become available for the workstations at each end.

6.2 High Definition Video (HDV) Studio

A simplified architectural diagram of the Sony High Definition Center (HDC) Studio located in Culver City is shown in Fig. 3. Shown are two production chains: one for real-time display of images using a lossy compressor manufactured by Alcatel, and one for non-real transfer of full fidelity masters. Two chains are required because in post-production, the full integrity of the data must be retained to maintain high image quality through many generations of mixing, dubbing, and addition of effects. The only important time requirement is that the process be moderately interactive. If short image clips can be shuttled back and forth on the order of a few seconds to minutes, this requirement can be met. The video and audio chains also include special hard disk arrays to cache up to 9 minute audio/video segments prior to being transferred to tape. These are required because the tape recorder cannot operate in non-real time. Another conventional redundant array of inexpensive disks (RAIDs) is used to cache network traffic prior to being dumped to the special real-time disks. A Fore ATM switch provides ATM OC-3 service to the non-real time chain, and DS-3 service to the real-time production chain, and interfaces directly to the JPL ACTS HDR via the Pacific CalREN network.

7. GROUND STATIONS

7.1 ACTS High Bit Rate Terminals

NASA joined with ARPA to procure five HBR terminals. Two terminals are dedicated for NASA experiments, two dedicated for ARPA experiments, and the State of Hawaii owns the fifth terminal and has agreed to participate in experiments with both agencies.

The HBR terminal contract is primed by Bolt Beranek and Newman Inc., (BBN) and the major components consist of a 3.4m antenna made by Prodelin, digital terminal electronics made by BBN and a 696Mb/s modem made by Motorola. The equipment operating in the 30/20GHz Ka band can provide SONET transmissions at OC–3 (155Mb/s) up to OC–12 (622Mb/s). The transportable terminal comes with a trailer that is used to carry the equipment from one location to another and also provides an environmental operating space for the indoor terminal electronics.

The transmit EIRP is >76dBW and the terminal G/T is >28dBK. The terminal burst modem can operate with BPSK (348 Mb/s) or QPSK (696Mb/s). With the use of Reed–Solomon correctional coding, the overall clear day bit error rate (BER) can be in the order of $>10^{-10}$ for QPSK, and $>10^{-12}$ for PRBS. Additional rain fade margins ranging from 3–dB in the uplink and 1–5dB in the down link, result in comparable transmission performance to fiber cables (BER 10^{-11}) and allows the experiment to operate in a seamless hybrid (satellite/cable) network.

7.2 High Bit Rate Terminal Locations

The JPL terminal site is not on the main JPL campus but is located approximately one mile S/SE of the campus, on the southeast side of the Information Processing Center (IPC) building. The IPC houses the CRAY Y-MP-264/T3D-256 and CRAY Y-MP-/232. Also, an INTEL Paragon [512 nodes] and an INTEL Delta [512 nodes] also are available about 7 miles away at the Caltech campus through a high-speed HIPPI channel. The JPL high performance computers at IPC are physically located very close to the ACTS HDR and thus requires only a very short cable run from the computers to the antenna located only a few meters from the side of the building (Fig. 4). The antenna transmits over the top of a parking lot and has an excellent view of the ACTS satellite.

The University of Hawaii terminal is located next to the Tripler Army Hospital on the island of Oahu. A high bit rate data channel connects the HDR terminal at Tripler via undersea cable, terrestrial cable and microwave to the Keck telescope on the island of Hawaii and the new supercomputer center of the island of Maui.

7.3 ACTS HDR Frame/Network Architecture

The HDR terminal interface is designed to complement the SONET hierarchy with the terminal acting like standard line terminating equipment. The terminal demultiplexes OC–3 and OC–12 terrestrial channels to satellite STS–1 and STS–3 transmissions. The data is coded in a Reed–Solomon format that are transmitted in blocks of 696–bytes in a satellite cell. Each cell contains three parallel R/S code words of 232 bytes. Each code word is formed

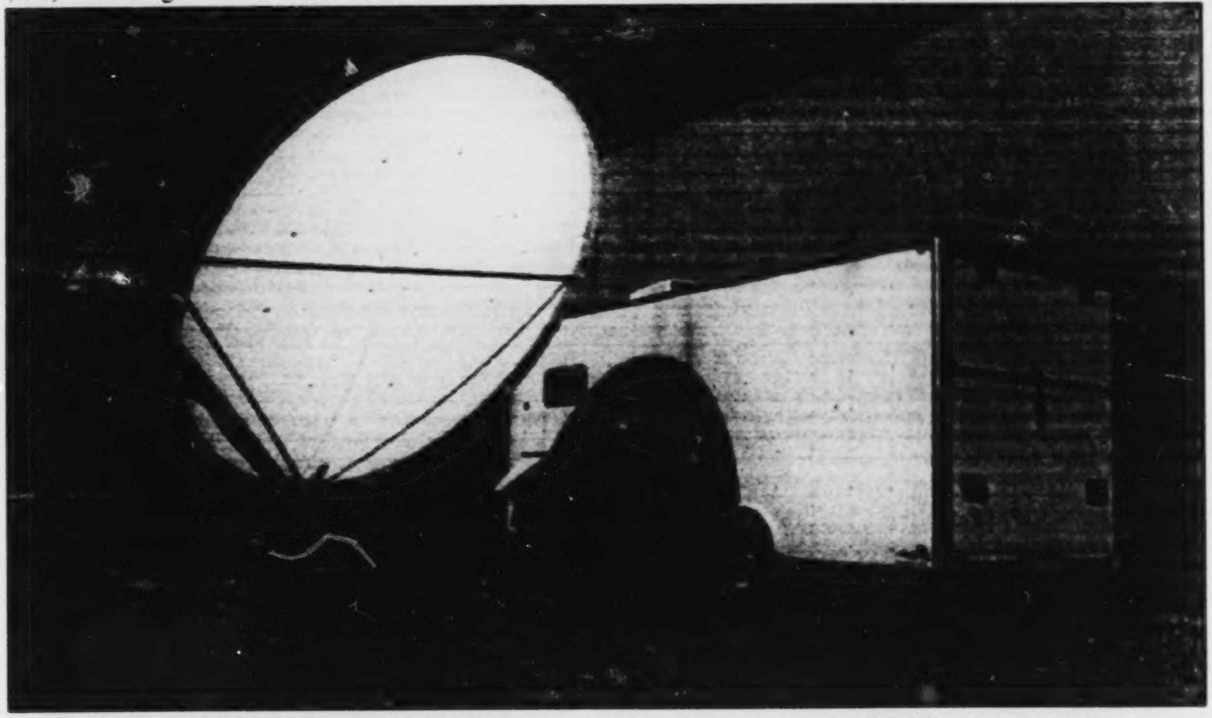

Fig. 4. The ACTS High Data Rate (HDR) ground station is shown setup near the JPL supercomputer operations center in Pasadena, CA. The installation consists of a 3.4-meter antenna dish and a transmitter/receiver unit housed in the nearby trailer. After disassembly, the trailer can also be used to transport the dish.

of 216 data bytes and 16 redundant (check) bytes, with an ability to correct up to 8 byte errors per code word. An STS–1 satellite channel uses 32 SONET frames (25,152 bytes of payload including the pointers) every 4 ms. The HDR network, depending on the required beam configuration from the satellite to the desired HDR(s) in the network, can connect three OC–3 full–duplexed channels, or one OC–12 channel simultaneously.

8. SCHEDULE

A 12-month implementation schedule is envisioned:

- Design, order, and install facilities. Test JPL to SPHDC ATM circuits (Oct–Dec 95)
- Conduct satellite network checkout from SPHDC to Hawaii in loopback (Jan–Mar 96)
- Conduct SPHDC to Tokyo Sony global network tests (Apr–Jun 96)
- Conduct remote post-production tests (Jul–Sep 96)

Since the JPL ACTS HDR and Japan Intelsat HDR will be checked out under other experimental efforts, most of these circuits will likely be functional by the time the effort begins. Only the ground links will likely have to be integrated and tested. It is hoped that the ground links will be available at low or no cost from local carriers due to the short duration and experimental nature of the effort. The Sony ATM facilities are now nearly installed and operational at both sites.

9. ACTS TIME SLOT ALLOCATION

Generally, it would be desirable to conduct the tests during normal working hours in Los Angeles and Tokyo, nominally 5–8PM PST. This would afford opportunities to perfect techniques and attempt different styles of editing. However, it may also be possible to conduct more limited tests on a space available basis.

10. CONCLUSIONS

Eventually, most areas of the world will be wired with fiber. In spite of this deep penetration, satellite will almost always provide a preferred means of providing portable high speed communications to remote regions mostly highly valued for motion picture on-location shooting. Furthermore, the high latency associated with satellites will not likely degrade the channel efficiency of these links since the transmissions are largely stream based.

11. ACKNOWLEDGMENT

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12. REFERENCES

[1] L. A. Bergman, "Gigabit Satellites in Distributed Supercomputing for Global Research," to be presented at *COMPCON'95*, San Francisco, March 6–8, 1995.

[2] L. A. Bergman, J. G. Cohen, and P. Shopbell, "Keck Acquisition, Visualization, and Control Over ACTS," *ACTS Results Conference*, NASA Lewis Research Center, Cleveland, Ohio, Sept 11–13, 1995.

[3] L. A. Bergman, "Trans-Pacific HDR Satcom Experiment For Distributed HDTV Post-Production," presented at *International Workshop on SCGII, Maui, HI*, Nov 11, 1995.

[4] L. A. Bergman, P. Gary, B. Edelson, and N. Helm, "High Data Rate ACTS Experiments For Performing Global Science: Keck Telescope and Global Climate Model," to be presented at *AIAA Conference*, Washington D.C., Jan. 1996.

[5] J.G.Cohen, L. Bergman, and P.L.Shopbell, "A High Speed Network for Remote Observing from Caltech with the Keck Telescope, submitted to ADSS.

Remote High Definition Video Post-Production Experiment via Trans-Pacific HDR Satellite Communications Link : Experimental Systems in Japan

Naoto Kadowaki*, Norio Shindo** and Takashi Iida*

*Communications Research Laboratory, MPT
4-2-1 Nukui-Kitamachi, Koganei, Tokyo, 184 Japan
Tel:+81-423-27-7513/7456, Fax::+81-423-27-6699/7459
E-mail:naoto@crl.go.jp / iida@crl.go.jp

**Sony Corporation
6-7-35 Kitashinagawa, Shinagawa-ku, Tokyo, 141 Japan
Tel:+81-3-5448-2657, Fax:+81-3-5448-7811
E-mail:alshindo@rd.sony.co.jp

1. ABSTRACT

Satellite communications systems are expected to play an important role in constructing the Global Information Infrastructure. A set of experiments known as The Trans-Pacific HDR Satellite Communications Experiment has been planned as a part of the Japan-U. S. Cooperation in Space Project to demonstrate the capability of high data rate and high quality transmission by satellite communications systems. As the first experiment, the application of remote high definition video post-production, which will be conducted between the two post-production facilities of Sony in the United States and in Japan was chosen. The idea is to transmit HD images, which were shot on-location, to a studio for the post-production processing, and then re-transmit the finished images back to the director on-location for his review. This paper describes the network configuration and HD video facilities that is being prepared in Japan for this experiment. The schedule of this experiment and plan of demonstration and evaluation are also described.

2. INTRODUCTION

In order to realize information infrastructure, higher transmission rate of networks is required to carry various types of information. Using fiber optic cable is an effective way to accomplish this purpose. On the other hand, a satellite communications system has advantages such as wide area coverage, capability of flexible network configuration and a nature of broadcasting type communications. The key that satellite communication is recognized as another efficient media for realizing Global Information Infrastructure(1) is to develop(2)(3) and prove the capability of high data rate transmissions equivalent to fiber optic cables.

A set of experiments known as The Trans-Pacific High Data Rate (HDR) Satellite Communications Experiment has been planned as a part of the Japan-U. S. Cooperation in Space Project to demonstrate the capability of high data rate and high quality transmission by satellite communications systems. After the information Society Meeting which was held among G7 countries in Brussels in February 1995, this experiment has been listed up as one of activities in G7 project "Global Inter-operability for Broadband Networks (GIBN)". As the first experiment, the application of remote high definition video post-production, which will be conducted between the two post-production facilities of Sony, Sony Pictures High Definition Center (SPHDC) in the United States and Sony High Definition Video Software Center (SHDVSC) in Japan, was chosen. The idea is to transmit high definition (HD) images, which were shot on-location, to a studio for the post-production processing, and then re-transmit the finished images back to the director on-location for his review. This application will likely reduce time and cost of program production in broadcasting and movie industries.

3. TRANS-PACIFIC HDR SATELLITE COMMUNICATIONS LINK

The experimental system concept is shown in Figure 1. A high data rate link between the United States and Japan will be established by the ACTS and Intelsat in early 1996. These satellites will connect the mainland of the United States to/from Hawaii and Hawaii to/from Japan, respectively. In the United States, ACTS HDR terminals(4)(5) will be set up in JPL and Hawaii to establish 155.52 Mbps satellite links. KDD, AT&T and TELSTRA are

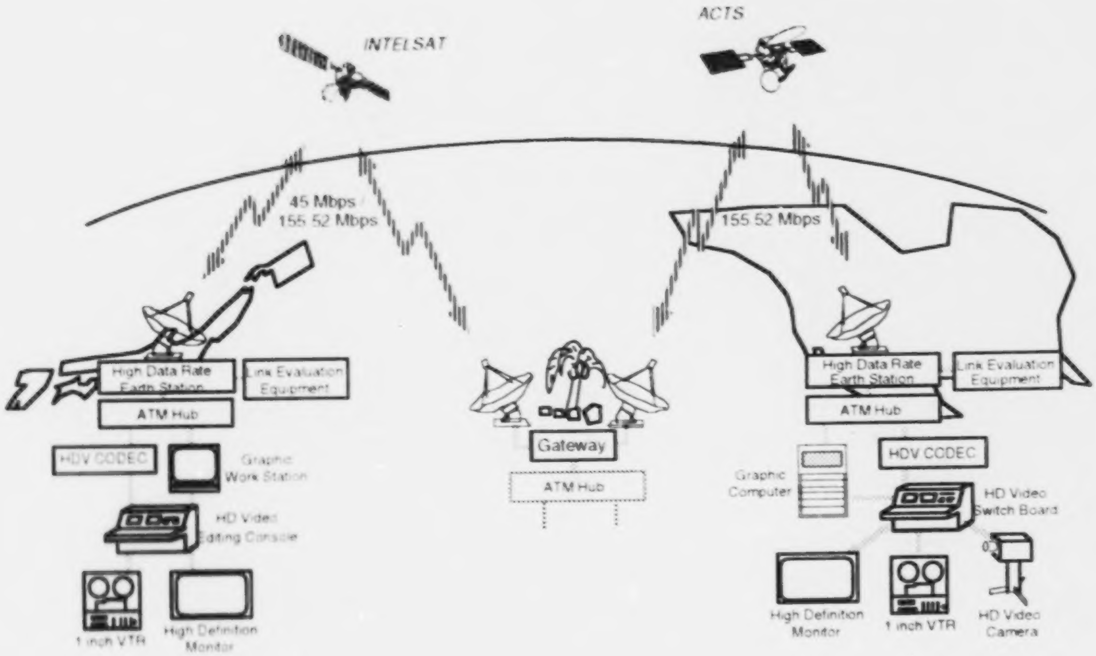

ACTS
INTELSAT
45 Mbps
155.52 Mbps
155.52 Mbps
High Data Rate Earth Station
Link Evaluation Equipment
ATM Hub
HDV CODEC
Graphic Work Station
HD Video Editing Console
1 inch VTR
High Definition Monitor
Gateway
ATM Hub
High Data Rate Earth Station
Link Evaluation Equipment
ATM Hub
HDV CODEC
Graphic Computer
HD Video Switch Board
High Definition Monitor
1 inch VTR
HD Video Camera

Figure 1 Concept of The Trans-Pacific High Data Rate Satellite Communications Experiment

currently conducting ATM transmission trial at 45 Mbps with Intelsat. Then the Intelsat link seems to be available for this experiment at the transmission rate of 45 Mbps with KDD's earth station. If earth stations which can transmit 155.52 Mbps signals are provided, Intelsat link can be used for transmission at such a higher rate. As a prospect of this experiment, the transmission rate of Intelsat - ACTS link will be 45 Mbps during the first phase and will be upgraded to 155.52 Mbps at the next phase. In these configurations, the trans-Pacific HDR satellite link will be connected to the experimental network which will be provided for the GIBN project.

The transmission protocols over the satellite link will be ATM / SONET combination. These protocols were adopted because they are specified as a part of B-ISDN standard and for further experimental applications such as ATM-LAN interconnection.

The configuration of the experimental network in Japan has been studied as follows. The network will be prepared in cooperation with KDD and NTT.

3.1 EXPERIMENTAL NETWORK FOR GIBN PROJECT

The trans-Pacific HDR satellite link is connected to application site via the experimental networking facilities provided for the GIBN project. To make an explanation of the network simple, the experimental networking facilities provided for the GIBN project are described at first in this section.

As shown in Figure 2, two ATM switching equipment will be installed at KDD Ohtemachi office and NTT Ohtemachi office. These ATM switches are connected by dedicated fiber optic circuits with STM-1 interface at the transmission rate of 155.52 Mbps. KDD will provide international communications circuit via submarine cables. Because the specification of international circuits is DS-3 at the transmission of 45 Mbps, an ATM switch in KDD Ohtemachi office has a function of protocol conversion between STM-1 and DS-3.

An ATM switch and routers will be equipped also at Communications Research Laboratory (CRL) headquarters in Koganei, Tokyo, and these facilities are connected to NTT Ohtemachi office by fiber optic link.

These facilities will be set up by CRL in cooperation with KDD and NTT by the end of March 1996.

3.2 PHASE 1 CONFIGURATION

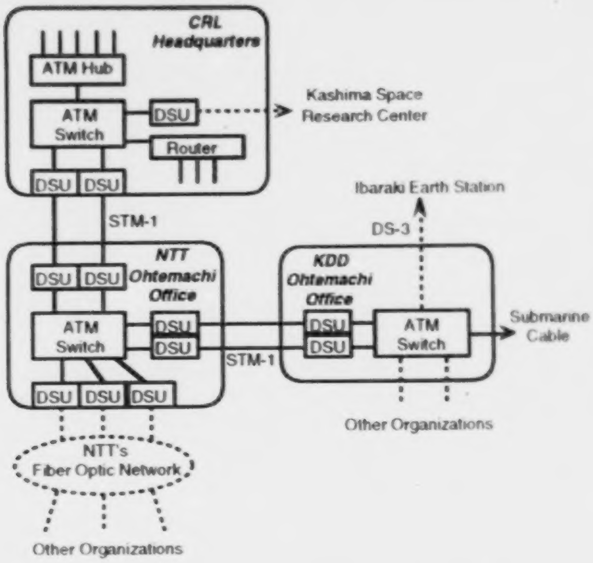


Figure 2 Networking Facilities for GIBN

Phase 1 configuration of the experimental network is shown in Figure 3 (a). In this phase, the satellite link is terminated by KDD's Intelsat earth station in Ibaraki prefecture. A DS-3 satellite modem at the transmission rate of 45 Mbps will be installed in the earth station. A 45 Mbps terrestrial circuit is already established between Ibaraki earth station and KDD's Ohtemachi office for KDD's own experiments with AT&T and TELSTRA. At KDD's Ohtemachi office, this terrestrial circuit is connected to the experimental network for GIBN and led to NTT's Ohtemachi office through ATM switches and fiber optic links mentioned in 2.1. Another NTT's fiber optic link will be provided for the connection between NTT Ohtemachi office and SHDVSC in Shinagawa, Tokyo.

3.3 PHASE 2 CONFIGURATION

Phase 2 configuration is shown in Figure 3 (b). CRL is under procurement of a new Ku-band earth station which will be set up in CRL's Kashima Space Research Center. This earth station will be able to transmit and receive OC-3 rate (155.52 Mbps) communication signals through Intelsat's transponder with 72 MHz bandwidth as well as DS-3 rate. The earth station is connected to CRL headquarters via fiber optic link which will be established until the end of March 1996. Since the fiber optic link employs SDH protocol, probably STM-4 at 622 Mbps, a protocol converters between STM-4 and OC-3 ,and between STM-4 and DS-3 are required at the earth station. An ATM hub which has STM-4 interface ports, DS-3 interface ports, and OC-3 interface ports can be used as such protocol converters. In CRL headquarters, the link is terminated at the ATM switch for the GIBN project. NTT Ohtemachi office and SHDVSC are connected via fiber optic link just the same as phase 1..

For experimental data gathering, a receiving power monitor and an ATM/SDH analyzer will be installed in CRL's earth station. A data gathering processor acquires data of both receiving power and ATM transmission quality concurrently. ATM analyzers will be placed also in the United States side to acquire precise error characteristics, and in Sony for measurement of end to end transmission quality.

4. HD VIDEO POST-PRODUCTION FACILITY

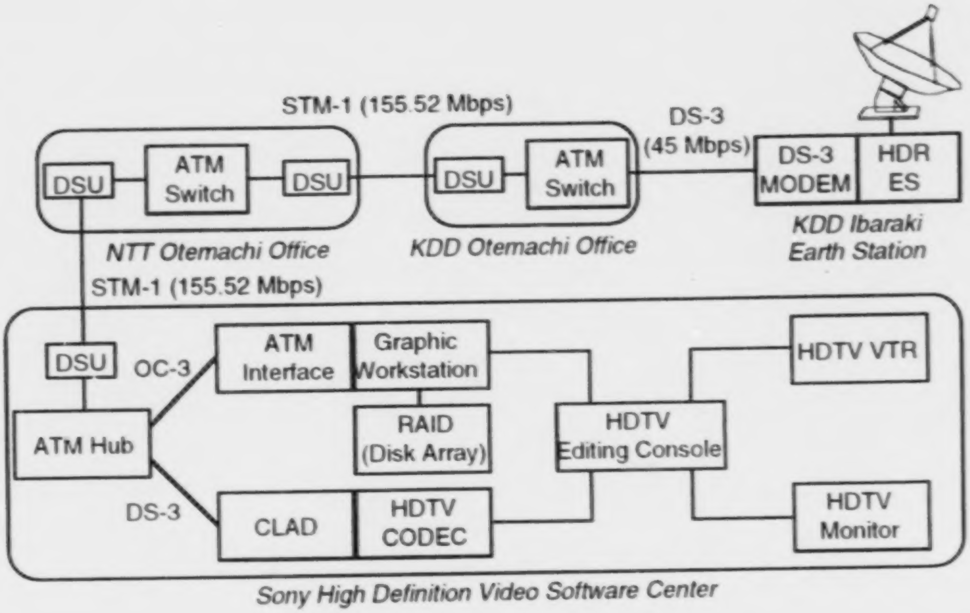
HD video post-production facility will be set up at SHDVSC in Shinagawa. An HD video editing console, HD video VTRs and HD video monitors are already installed, and a disk array (RAID) will be installed by the end of this year. As shown in Figure 3, there are two streams between an HD video editing console and an ATM hub. One stream will be used for non-real time uncompressed HD video transmission, and another is for real time compressed HD video transmission.

For non-real time transmission, a graphic workstation such as SGI workstation with ATM interface will be set up and will work as a disk array controller, as well as a computer graphics processor. It will record uncompressed digital HD video signal at 1.188 Gbps onto a RAID and will read out the recorded HD video frame slowly so as not to exceed the capacity of the communication link when the HD video frames are transmitted.

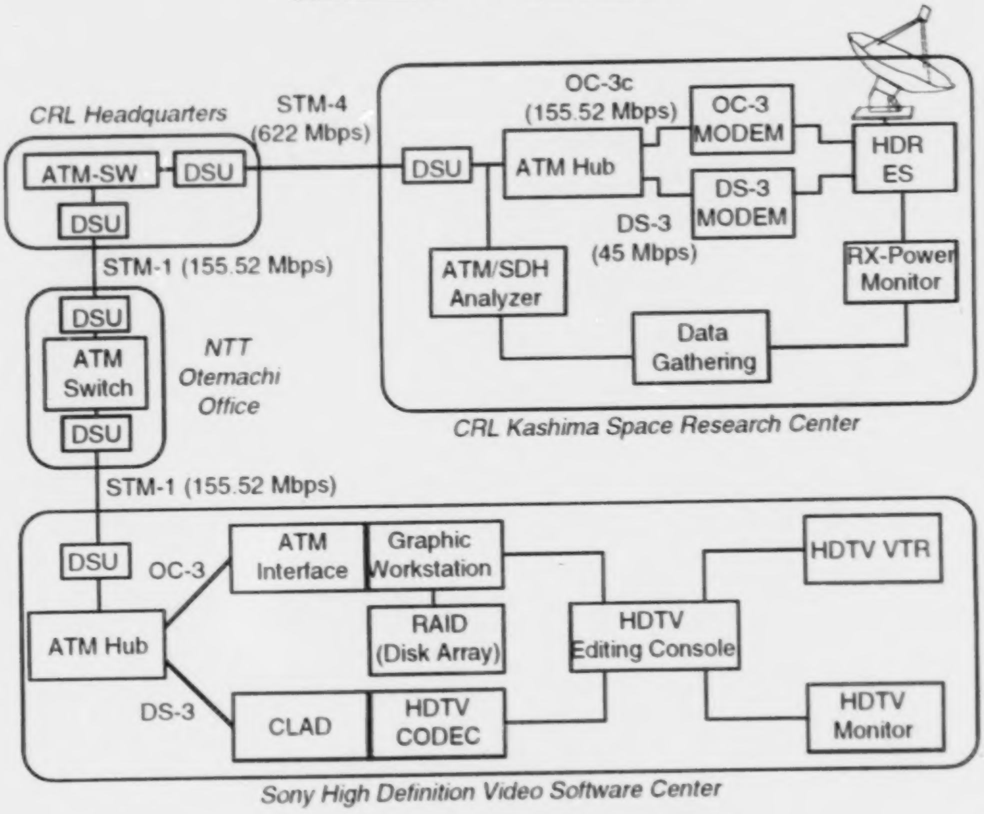
For real time transmission, HD video signals are fed into an HD video CODEC to be compressed, and mapped into payloads of ATM cells by a CLAD. When SHDVSC receives compressed HD video signals, the signals are fed into a CLAD to be disassembled from ATM cells to sequential digital signal and decompressed by an HD video CODEC.

5. DEMONSTRATION AND EVALUATION

The establishment of ATM-based high data rate satellite link connection is the first aim of this experiment. To achieve this, an evaluation test of ATM transmission quality is planned between Sony


STM-1 (155.52 Mbps)
DS-3
(45 Mbps)
DSU
ATM
Switch
DSU
DSU
ATM
Switch
DS-3
MODEM
HDR
ES
NTT Otemachi Office
KDD Otemachi Office
KDD Ibaraki
Earth Station
STM-1 (155.52 Mbps)
DSU
OC-3
ATM
Interface
Graphic
Workstation
HDTV VTR
ATM Hub
RAID
(Disk Array)
HDTV
Editing Console
DS-3
CLAD
HDTV
CODEC
HDTV
Monitor
Sony High Definition Video Software Center

(a) Phase 1 : DS-3 base configuration


CRL Headquarters
STM-4
(622 Mbps)
OC-3c
(155.52 Mbps)
OC-3
MODEM
ATM-SW
DSU
DSU
ATM Hub
HDR
ES
DSU
DS-3
MODEM
DS-3
(45 Mbps)
STM-1 (155.52 Mbps)
ATM/SDH
Analyzer
RX-Power
Monitor
DSU
ATM
Switch
DSU
NTT
Otemachi
Office
Data
Gathering
CRL Kashima Space Research Center
STM-1 (155.52 Mbps)
DSU
OC-3
ATM
Interface
Graphic
Workstation
HDTV VTR
ATM Hub
RAID
(Disk Array)
HDTV
Editing Console
DS-3
CLAD
HDTV
CODEC
HDTV
Monitor
Sony High Definition Video Software Center

(b) Phase 2 : DS-3 / OC-3 base configuration

Figure 3 Network Configuration in Japan for The Trans-Pacific HDR SatCom Experiment

and Intelsat earth station.

After the establishment of the trans-Pacific HDR satellite link, the feasibility of the remote HD video post-production will be demonstrated. Uncompressed HD video source to be edited is transmitted in non-real time manner from the United States. Locally stored HD video source is inserted to the transmitted video and the edited video will be sent back to the United States in non-real time manner without any compression. In order to make the video reviewed instantly, compressed real time transmission is also available.

Concurrently, the quality of the satellite link will be evaluated. Especially in phase 2, the correlation between receiving power and ATM/SDH transmission quality, for instance cell loss, HEC error, far end block error (FEBE) and so on, can be evaluated. In case of out of service, end to end link quality such as bit error rate and cell transmission delay can be measured with ATM analyzers set up at SHDVSC and the United States side. In addition, ATM traffic monitoring will be done through remote HD video post-production experiment. This is helpful to obtain data of cell traffic characteristics in HD video transmission and other communication applications which will be done after the remote HD video post-production demonstration.

Subsequently, several different application demonstrations will be done. As one of such applications, remote astronomical observation experiment is proposed by Astronomical Society of Japan and CRL. This application will show a night sky in the mainland of the United States or Hawaii to Japanese people in the afternoon in Japan with very high definition image quality. The aim of this application is to stimulate people's interest in astronomy and science.

6. SCHEDULE OF THE EXPERIMENT

The network configuration for the experiment is determined, and required equipment and facilities for phase 1 configuration will be prepared by the participants such as CRL, Sony, KDD and NTT by February of 1996. Connectivity test of each part of the network will be done through the period of preparation. After the phase 1 domestic connection is accomplished, loop back test between SHDVSC and KDD will be performed.

The capacity of Intelsat for this experiment will be available in February 1996. After a verification of an end to end connection between the SPHDC and the SHDVSC, the remote HD video post-production experiment will be started.

For phase 2 configuration, CRL already started defining specifications of the Ku-band earth station and related networking facilities such as ATM switches. These facilities will be ready for the experiment in mid-1996. The operation of this earth station is expected in August 1996 after passing an earth station verification test for Intelsat access. The remote HD video post-production experiment will be continued with this configuration at OC-3 rate. Various measurements for the evaluation of link quality will also be started at this stage.

This experimental network will be kept for almost three years as a part of GIBN project. Different type of application experiments are expected to be done within this period.

7. CONCLUSION

The construction of Remote HD Video Post-Production Systems for the Trans-Pacific HDR Satellite Communications Experiment has been started in both the United States and Japan. The United States team has already prepared most of necessary equipment and is planning to conduct a local terrestrial connection test between JPL earth station and SPHDC. Also in Japan, the preparation for the experiment has been proceeded.

The remote HD video post-production is one of the technology innovations that changes program production scheme in broadcasting and movie industries. And this kind of application is a typical one which requires global high data rate communications networks. Subsequently, different type of applications such as remote astronomical observation are proposed. To provide worldwide coverage and flexible access method, satellite communications system is the most effective media. From this point of view, this experiment will show the usefulness of high data rate international satellite communications systems.

ACKNOWLEDGMENT

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REFERENCES

(1) Remarks prepared for delivery by Vice President Gore, ITU, Mar., 1994.

(2) T. Iida, . Ohmori, N. Kadowaki, E. Takano and J. Aoyama, "Study on The Satellite for Gigabit Communications in Japan", 15th AIAA International Communications Satellite Systems Conference, AIAA-94-1073-CP, 1994.

(3) N. Kadowaki, T. Iida and S. Ohmori, "Satellite-Based Gigabit Networking Technology and a Demonstration Experiment", 19th International Symposium on Space Technology and Science, ISTS 94-i-05, 1994.

(4) ACTS HDR System Description, NASA Lewis Research Center, May, 1993.

(5) B. Kearny, "High Data Rate Modem for Support of ACTS Gigabit Network", 15th AIAA International Communications Satellite Systems Conference, AIAA-94-0934, 1994.

THE FUTURE OF THE INTERNATIONAL TELECOMMUNICATIONS ACCOUNTING RATE REGIME

James Savage
GTE Telephone Operations
Irving TX USA

ABSTRACT

NB: The views expressed herein are solely those of the author and do not necessarily reflect those of GTE or its affiliated companies.

This paper reviews the future of the international telecommunications accounting rates regime and assesses prospects for carriers in the world to come. Following a brief primer on how the current regime works, the paper reviews how this multilateral regime evolved within the International Telecommunication Union (ITU) framework, and why in fact it constitutes the heart of how international telcos make money. The regime slipped into disequilibrium in the 1980s, and the paper reviewes who wins and loses from the current inequality. The paper presumes that changes to the status quo are already under way and reviews several possible models that may replace the current system.

I INTRODUCTION

When the famous criminal Willie Sutton was asked why he robbed banks, his answer was "Because that's where the money is". For international telecommunications carriers, the dry and dusty world of accounting rates provides their largest single source of revenue. Ask any international carrier, reseller, or call-back operator: the accounting rate regime is -directly or indirectly - where the money is. Yet this cosy world, established in the gentlemanly days of PTT monopolies, is under siege from every possible angle. The prognosis for its continued survival is not encouraging.

This may be the most dramatic event to be confronting telecoms carriers during the last half of the decade. Yet in fact it has attracted little publicity. This is due in part to the sheer complexity of the accounting rate regime; it is an issue that defies any easy analysis. Many developing countries, even those with privatized carriers, are loath to shine too bright a light on this topic, as accounting rates provide them with important sources of foreign exchange. indeed, for some countries telecom settlements are *the* largest source of foreign exchange.

There is another major point, of importance even within countries with competitive environments. Unlike most things we buy, international telecom service is priced in a way that bears virtually no relation to cost. The actual cost of telecoms service has plummeted far faster than even the most dramatic decreases in rates.

This paper looks at the coming collapse of the international accounting rates regime and the prospects for carriers in the world to come. Beginning with a brief primer on how the current regime works, the paper reviews how this multilateral regime evolved within the International Telecommunication Union (ITU) framework, and why in fact it continues to constitute the heart of the international telecoms world. The system slipped into disequilibrium during the 1980s, never to emerge. We review how and why that happened, and how it was a harbinger of today's threats. This paper analyses the winners and losers of the present structure and the political and economic sensitivities underlying the inevitable changes taking place. Finally, we look at the world to come and review several possible models by which international telecoms settlements may take place, and what new sources of revenue might sustain today's carriers.

I Follow the Money: Accounting and Settlement Rates Explained

a. How the System is Supposed to Work

The regime of international telecom accounting rates, through labyrinthine and nearly-ancient formulae, determines what we pay when we place an international call.

Every telephone call placed between two countries launches a complex series of financial transactions. The current international telecommunications accounting and settlement rate regime has evolved over many years, and remains the financial backbone of international telecommunications.

The framework for this regime, to which all ITU member-states adhere, is determined by Study Group III of the ITU Standardization Bureau, formerly the CCITT. Like many ITU telecom regulations, it evolved from the days of international service PTT monopolies, and was modelled largely on the international settlements process between postal administrations.

The foundation of the system is the establishment of *accounting rates* between carriers. This rate, defined as the per-minute revenue to be shared between correspondent carriers, determines the *settlement rate*. As the amount the originating carrier is obliged to pay, the settlement rate is usually half the accounting rate.

For calls between countries with *correspondent agreements* the transaction is quite straightforward. Within such a revenue-sharing agreement, each country must pay the settlement rate multiplied by the number of outgoing minutes.

In addition, carriers often enter into an *allocation agreement* with an international correspondent. In cases where competing international providers exist, such an agreement allows carriers to "reserve" a proportion of bilateral traffic for one another.

International carriers do not have correspondent agreements with all other countries, although direct facilities agreements, on average, comprise 95% of international outbound traffic. But every so often someone will place a call from, say, Malaysia to Uruguay. Such calls are sent via *transit service*, wherein traffic between two correspondents is sent to an intermediary for completion. That intermediary is acting as a *carrier's carrier*, and will charge a given transit rate for providing this service.
Acting as a transit carrier can be a profitable sideline: MCI estimates its current transit contract, serving 39 European, Asia-Pacific and Latin American carriers, is worth $ 175 million.

In cases where (usually quite small) international carriers have a correspondent agreement but no facilities, the carrier's carrier may handle all traffic as well as all settlements between the countries. The carrier's carrier will charge a *cascading rate* for administering the settlements process.

In theory, telecoms traffic and hence settlements between countries should be roughly equal. Countries should pay out about the same as they receive in settlements. Such a state of affairs usually requires countries to have relatively equal *collection rates*. The collection rate is that "retail" rate charged the customer.

b. How the System Really Works

The accounting rate system was designed for a fairly quiet world of manageable operator-assisted international traffic volumes. Most of us can recall when placing an overseas telephone call was a relatively dramatic event, often involving a series of operators, poor connections, and minutes if not hours spent sitting by the phone waiting for the international operator to ring back once connected.

Such was the state of international telephony only 10-15 years ago. International direct dialling came into its own in the early 1980s. Phone cards, country-direct services, digital technology, and (in some countries) competition in international services fuelled a massive increase in the volume of international telephone traffic.

In the developed world, by the late 80s it was as easy to place an international call as a domestic one. As Gregory Staple notes, "the luxury overseas call of the 1960s has become the routine global chat of the 1990s"[1]

Amidst this great increase in the number and duration of calls, some imbalances began to emerge. By the mid-80s it was evident that certain countries made more international calls than others. Patterns began to emerge. It became obvious that countries with lower *collection rates*, such as the US, Britain, and Canada, became sizeable net "exporters" of international calls.

International settlements have become a somewhat controversial issue as a result of discrepancies between international collection rates, or the rate charged to the customer. Rates in the US and other countries with competitive environments tend to be lower than in correspondent countries, sometimes dramatically so. Consequently, in the US case, outbound minutes greatly exceed inbound minutes, such that US carriers are responsible for net outpayments of over $ 2 billion a year.

In other words, major international carriers in competitive environments are victims of their own success. The more traffic they send from their home markets, the greater the outpayment. Remember, 50% of the accounting rate (ie, the settlement rate) is paid per outbound minute. If the US or UK sends twice as much traffic to country X than it receives, then it will pay out twice as much as it receives.

US, British, and Canadian international carriers - all net outpayers - accuse some administrations of maintaining artificially high collection rates and actively discouraging their customers from placing outbound international calls. High-priced countries become net importers of telecoms traffic and benefit from large net inbound settlements. As is detailed below, many developing countries employ high collection rates for this reason, maintaining that cross-subsidies from net international revenues collected are vital for the construction of a modern national network. But even in developing countries users are employing call-back services and other means of bypassing the home carriers in order to take advantage of lower rates elsewhere.

Even proponents of the current regime agree that the ITU/CCITT settlements methodology needs to better accommodate today's rapidly changing telecoms environment, if only to prevent abuses and bypass.

II. WINNERS & LOSERS: THREATS TO THE PRESENT REGIME

a. How this became an issue

1. The Empire Strikes Back: The International Traffic Apportionment Norm

The deregulation of international telecoms service took place in the United States, United Kingdom, and Japan in a rapid-fire fashion through the mid-1980s. For the first time, administrations around the world started receiving traffic from and sending traffic to multiple counterparts within one country. The ITU rate structure was not designed for this sort of development but did accommodate it, after a fashion. Countries with multiple international carriers began forging allocation (or partitioning) agreements (defined above) with their correspondents, such that an international apportionment norm now governs international traffic flows and settlements.

This norm is powerful: a new US-based international carrier, for example, will only be able to receive as much international traffic as it can send. It would not be able to exclusively or even predominantly import traffic from a given country or countries, as it could not by itself send all or most outbound minutes. This norm affirms the strength of the "big 3" in the US case, and established international carriers in all cases. It adds considerably to the price of new entry into the international carriage market.

2. Competitive Carriage and Competitive Rates: A World of Imbalances

The combination of competitive forces and advancing technology has led to a dramatic decrease of the cost of providing international telephone service. International service collection rates have decreased dramatically in countries with competitive environments, and outbound traffic has risen accordingly.

This quickly led to a world of imbalances, in which competitive markets feed larger volumes of traffic to monopoly countries than they receive in return. Worse, the settlements structure

834

explained above seems to encourage this distortion. For example, if countries A and B have an accounting rate of $1.00, they will pay each other a settlement rate of $0.50 (half the accounting rate) multiplied by the number of outbound minutes of traffic. Therefore, if country A sends twice as much traffic to B than B sends to A, then A pays twice what it will receive from B. A's outbound traffic is to B's benefit.

This distortion has led to an unusual set of circumstances: the more outbound international traffic a carrier generates from its customers, the more it will have to pay as outbound settlements. If it sends more traffic than it receives, then it will be a net outpayer and will run a telecoms traffic deficit. The USA paid a net outflow of over $ 2 billion in 1992. One commentator noted that the US outpayment equalled 35% of the total US budget for foreign aid.[2]

3. Accounting Rates as a North-South Issue

Many developing countries have come to rely on large net inbound settlements to subsidize construction of the network. In a number of countries inbound settlements constitute the single largest source of hard currency. A large number of developing countries continue to argue that the settlements process is an entirely legitimate means by which they can subsidize their telecoms development. Indeed, they argue that it has been exactly through such cross-subsidies that developed countries were able to create and maintain their national networks.

While it is true that all developed countries have telephone networks born of monopoly, the cross-subsidy-for-development argument carries less and less weight as the digital age progresses. High collection rates may create inbound accounting rate revenue for the national telecoms carrier, but such rates may act as an export tax on the country as a whole, as residences and businesses are subject to higher rates. Moreover, technology now permits several means by which a user may bypass high collection rates. Therefore, those least likely to benefit from high outbound rates are those most likely to have no choice but to pay them.

It must be noted that even "lower" competitive international collection rates bear little actual relation to the cost of providing the service. Monopoly international carriers continue to have considerable power to base accounting rates on other criteria. The ITU Standardization Bureau, which establishes the methodology by which the settlements process takes place, has recommended that rates move toward a cost-based environment.

In competitive markets rates have in fact plummeted. In 1975, a three-minute daytime call from London to New York cost $ 22.50. That same call today costs $ 2.20. However, it is important to note that the cost of providing that call has also plummeted, to 33 cents for that same three minute UK-US call.[3]

In economic terms, the international telephone rate regime remains a cartel arrangement amongst monopolies. Although the most powerful actors within the international telecoms environment - the major countries as well as the major international carriers - no longer find this regime advantageous, it is not easily changed.

This is not because the developing countries who benefit from the accounting rate system enjoy any special power within the ITU or elsewhere. It is more a function of the natural evolution of multilateral regimes. Stephen Krasner noted this several years ago:

> When regimes are first created there is a high degree of congruity between power distributions and regime characteristics: powerful states establish regimes that enhance their interests...Once a regime is created, adjustment is likely to involve altering rules and decision-making procedures. But power distributions are more dynamic - they are constantly changing...Over time incongruities develop...[4]

In other words, the evolution of the accounting rate regime is lagging behind the progress of the marketplace. The incongruities or distortions created by a pricing mechanism out of sync with real costs has led to certain opportunistic "cottage industries" being created, the most visible of which is call-back operators. Call-back systems allow customers in a country with high outbound rates to obtain dialtone from a country with low international rates. For example, if rates from Ruritania to France are $ 2.50 a minute, and rates from the US to France are $ 0.45 a minute, a Ruritanian consumer may arrange to pay a call-back operator $ 0.75 a minute to access US dialtone. The Ruritanian dials a US number and lets it ring but not connect. The call-back operator identifies the caller and returns the call. When the Ruritanian answers the phone, he has a US dialtone. He then dials Paris as though he were sitting in New York, and pays the US rate plus a premium to the call-back operator.[5]

Another opportunistic means by which operators in smaller countries benefit from the distortions of the accounting rate regime is by becoming hubs for audiotex service operators. The FCC calls such services "dial-a-porn", although by no means all audiotex operators offer services of a prurient nature. In this case, a service is advertised as "free" to the extent that "only toll charges apply". However, these services are domiciled in countries with relatively high international accounting rates, eg Moldova or Guyana, and a percentage of inbound settlements will be shared with the audiotex service provider responsible for generating the inbound traffic. Audiotex services now account for over 1.5 % of all international traffic - over 65 million minutes a month.[6] Countries that generate a lot of outbound audiotex traffic, such as Germany and Italy, have only taken steps within the past year to curb this distortion by seeking lower accounting rates.

These opportunistic industries, whose entire existence depends upon the current international accounting rate structure, are the most striking illustration of a distorted economic environment. Carriers employing such mechanisms to exploit this distortion are behaving in a completely rational and, indeed, often quite clever way.

As David Frum said of agricultural subsidies, the international accounting rate regime is in fact "intellectually indefensible". It is an economic artifice that bears no relation to cost-based pricing, and it is an archaic holdover from the days of monopoly PTTs. But it continues to profit many...And very few aspects of international trade are free from economic distortion. Is it premature to say the current international accounting rate regime is dying? Or will it merely change form?

III. THE FUTURE OF INTERNATIONAL ACCOUNTING RATE REGIME

Even the International Telecommunication Union (ITU) has recognized the need to evolve towards cost-based international accounting rates, through Resolution D.140 of the CCITT (now the ITU Standardization Bureau). Most of the pressure to lower rates has come from the US Federal Communications Commission (FCC), Britain's Office of Telecommunications (Oftel), and Canada's Canadian Radio-Television and Telecommunications Commission (CRTC).

The US international telecoms carriers are the largest net outpayers, and hence have been the strongest lobbyists for change to the international accounting rates regime. AT&T keeps a list of what it terms "egregious countries": those countries that have the highest rates and gain the greatest percentage of their total revenues from accounting rate settlements.

Some US observers also draw parallels with the changes to the US system of local access charges levied against interexchange (long distance) carriers. As long distance networks evolve into local carriers and vice versa, the access charge structure will disappear. While the concept of universal service remains a strong public policy objective in the US (akin to the ITU's right to communicate norm), it appears likely that cross-subsidies are no longer viewed as a wholly legitimate means of funding universal access. In its place a number of observers and policy-makers propose a universal service fund to which all carriers would contribute. Some have proposed a similar worldwide fund to accompany the rate rebalancing that would be a necessary consequence of cost-based international rates.[7] Also, just as price-cap regulation has tempered the effects of uninhibited price rebalancing, some equivalent structure will be necessary at the international level to provide rules of the road to international carriers.[8]

Whether or not carriers subscribe to the practice of cost-based rates, it appears all are in agreement that the concept of cost-based international accounting rates should be the international norm governing settlements between international carriers.

How might cost-based rates be achieved?

1. The Postal Model

The world of postal settlements is not unlike that of international telecommunications settlements. There are competitive domestic and international carriers (private couriers such as DHL, TNT etc) and resellers (postal administrations that maintain lower international rates in order to attract international bulk mail business, eg Denmark, Malaysia, the Dominican Republic). Couriers are full-service carriers that handle every aspect of the delivery of a package of letter. No revenue is shared with postal administrations. Couriers employ cost-based pricing and usually charge much higher rates than postal administrations, which in most countries lose money and are run as a government service. In countries where postal administrations have been restructured into state corporations, such as Canada or New Zealand, these administrations have come to closely resemble their courier competitors.

Applied to telecommunications, the postal model depicts a transitional stage in which many if not most countries maintain tradtional PTT structures and traditional settlement agreements. But, as with couriers, a parallel telecoms world will exist where competitive international service providers may provide "both ends of the pipe", even to the level of the local loop. These services will be priced competitively and marketed aggressively, just as domestic long distance is in the US, Canada, New Zealand, Britain, Australia and elsewhere.[9] Couriers have taken much of the most lucrative postal business away from postal administrations. Postal services, in turn, have had to work harder to justify their budgets -and especially their losses. Likewise, telecom administrations are already privatizing and forming alliances in order to ensure their survival in a fully-competitive environment. In other words, even if they remain state-owned, they are coming to more closely resemble their private sector competitors. And, like courier companies, all major telecom carriers are now looking well beyond their own national boundaries.

2. The Civil Aviation Model

International civil aviation does not seem at first glance to be a particularly attractive model. Aviation tariffs are, if anything, far more complicated than telecom accounting rates. But the telecommunications world may come to quickly resemble the civil aviation world to the extent that a smallish number of very large carriers will dominate all major world routes - at both ends of the route. Airlines pay the equivalent of access charges to local authorities in order to land airplanes at a given airport. Access charges to local telecom exchange carriers will, in this model, be supplanted by the kinds of local access fees to municipalities that cable television providers in North America must pay.

3. Flat Rate Pricing

Already, one of the major traditional distinctions between local telephone service in Europe and North America is that in the latter local service is priced at a flat rate. Local minutes of use are consequently much higher in North America. Businesses and other large enterprises may lease lines and arrange for virtual private network service from carriers, thus creating their own flat-pricing structure. Some observers believe it is only a matter of time - and not much time at that - before all international telecoms traffic employs flat-rate pricing. Flat-rate pricing for international traffic, regulated by a price cap mechanism, may indeed be the most likely outcome following the end of the accounting rate regime.

IV. CONCLUSION

Conceptually, many people within the industry perceive international telecoms traffic as a costly service. It is not. In fact, a 1993 study estimated that if settlement rates fell to their cost-based levels, including factors such as domestic distribution, cable construction, etc, price would fall by 63% for US-originated traffic and by 88% for international traffic terminating in the US.[10]

Nevertheless, many developing countries rightly maintain that cost-based pricing will leave them with no means of earning hard currency for network development. But using inbound settlements as a cross-subsidy is not a

837

mechanism with a bright future. The accounting rate system is seen as deeply flawed and the most powerful countries and carriers in the international telecoms world are the same countries that are agressively trying to scrap the current regime.

While economists have clearly depicted the distortions and inequalities of the current regime, less effort appears to hqave gone into thinking about how developing countries reliant on settlements will replace that revenue. In poor countries, domestic rate rebalancing will only take you so far. The market may not be able to bear actual cost-based pricing, which remains itself a matter of controversy even in many developed countries.

The International Telecommunications Union (ITU) has proposed, on different occasions and in different forms, a global fund for international telecoms development. Most of these plans were voluntary and ultimately attracted little money. More recently, the ITU formed WorldTel, a new financing and operating entity that will act as a financing mechanism between countries in need and private investors seeking profitable returns.[11] The role to be played by the ITU in all this remains somewhat unclear, but the ITU may provide a good forum for a multilateral "universal service fund".

The accounting rate regime will not disappear overnight. Countries and carriers will evolve away from the regime at varying rates. The progress of international simple resale is evidence that such a chain of events is already well under way. Development in technology and the emergence of a competitive environment for international carriage can mean only one fate for the accounting rate regime. Carriers, regulators, and multilateral institutions are nevertheless only now really beginning to address what the telecom world might look like after the regime is gone.

APPENDIX

INTERNATIONAL TELECOM ACCOUNTING RATES

DEFINITIONS: WHAT YOU NEED TO KNOW

Correspondent Agreement: A revenue-sharing agreement between a given international service provider and international service provider in another country. Revenue will be shared for calls that terminate, originate, or transit their gateways.

Accounting Rate: The per-minute revenue that is to be "shared" between correspondent partners. Generally set in US dollars, other major currencies (Yen, DM, Sterling), SDRs (Special Drawing Rights), or gold francs.

Settlement Rate: This rate represents the per-minute amount one correspondent owes for terminating its traffic in another correspondent's service area. This amount is usually one-half the accounting rate (less any transit fees if applicable).

Collection Rate: This is the "retail" level of the transaction. It is the amount which customers are charged for international message toll service (IMTS) calls. Like any retail price, these vary according to volume, demand, costs to the carrier, regulatory constraints, desired profit margins, what the competition charges (if applicable) and what the market will bear.

Allocation/Partitioning Agreements: A bilateral agreement between two international carriers which designate a proportional return of traffic between two correspondents. For example, if "Ruritania Telecom (RT)" sends KDD 60% of all Ruritania to Japan traffic, KDD will in turn send 60% of its Ruritania terminating traffic to "RT". [12]

1. G. Staple, "The Explosion of Place" in TeleGeography 1993, edited by G. Staple (Washington DC: TeleGeography Inc, 1993), p. 51.

2. Haring, John; Rohlfs, Jeffrey; Shoosan III, Harry. The US Stake in Competitive Global Telecommunications Services: The Economic Case for Hard Bargaining, (Bethesda, MD: Strategic Policy Research, 1993), p. 2.

3. A. Adonis, "Lines Open for the Global Village," Financial Times (London), 17-18 September 1994, p. 24.

4. Stephen Krasner, "Regimes and the Limits of Realism," in International Organization 36:2 (Spring 1982), p. 499.

5. Discussions of call-back services may be found in Priscilla Awde, "Resale and Callback: Tweaking the Tiger's Tail", Global Telecoms Business 7 (Dec 1994-Jan 1995), 32-34; and Vince Vittore, "Call-back Operators Stir Debate Over Volume Resale" in America's Network, 1 May 1995, 38-43.

6. "Men (Mostly) Calling!" in TeleGeography 1994, ed. by Gregory Staple (Washington: TeleGeography Inc and IIC, 1994), p. 66.

7. Shirley Fujimoto, "Telecommunications Convergence: Fuelling Downward Pressure on International Accounting Rates" in PTC'95 Proceedings, R. Nickelson and D. Wedemeyer, eds. (Honolulu: Pacific Telecommunications Council, 1995), pp. 173-178.

8. A valuable discussion of price cap regulation and its application is found in Patrick Xavier, Price Cap Regulations for Telecommunications: A Review of Policies and Experiences, Paris: Organization for Economic Co-operation and Development (OECD) Working Party on Telecommunications and Services Policy, 1994.

9. Carriers that continue to enjoy monopolies may be surprised the extent to which they will have to market their services. See Sam Paltridge, "Global Telecommunications Advertising," in Pacific Telecommunications Review, 14:2, December 1992, p. 24-30.

10. Haring, Rohlfs, and Shooshan, Ibid., p. 9.

11. McKinsey & Co., Closing the Global Communications Gap. Sydney: McKinsey & Co., 1995.

12. J. Savage and B. Maddox. International Telecommunications Accounting and Settlement Rates: A Primer. (GTE, Internal, 1994), pp. 5-7.

The Impact of Boomerang Boxes and Callback Services on the Accounting Rate Regime

Robert M. Frieden
Associate Professor, The Pennsylvania State University
201-D Carnegie Building
University Park, Pennsylvania 16802
(814) 863-7996
e-mail rmf5@psuvm.psu.edu

Abstract

Technological innovations, the porousness of incumbent carrier networks and entreprenurialism contribute to the proliferation of international long distance services. Many of these services avoid being subject to the customary division of toll revenues using an accounting rate typically well in excess of actual service costs. Boomerang boxes and callback services make it possible for users to secure dialtone and services at a fraction of what incumbent carriers have charged. This paper will examine the impact of such services on the accounting rate regime and the manner in which incumbent carriers have managed the international switched telephony business.

In the Old World Order in international telecommunications a small number of international telecommunication service providers negotiated "operating agreements" to arrange for the interconnection of lines, and the division of toll revenues for calls between nations. This arrangement provided for a correspondent relationship that presumably identified the few number of legitimate players in the routing of international calls, including the domestic "tail" circuits running to and from gateway facilities.

Operating agreements included an "accounting rate" to be used as the amount of compensation shared by the carriers ostensibly set to reflect the approximate costs the carriers incurred.[1] However, for most routes correspondents have failed to reduce the accounting rate to reflect lower costs achieved by technological innovation and economies of scale.

High accounting rates and commensurately high end user charges present a lucrative market for entrepreneurs providing "call-back" services[2] to evade or interpret liberally regulations or laws that prohibit, limit or condition market entry. The New World Order in international telecommunications makes it possible for companies with limited budgets to enter a more accessible, competitive and flexible marketplace and thereby exploit high accounting rate and end user charge differentials.

"Code-calling" via callback service providers enable callers, in high cost locations, to place a call to the United States or another country with low outbound international calling rates. The caller dials an international telephone number, hangs up before the call is answered and then receives a call originating from the country providing a second dialtone with outbound calling capability.[3]

At the micro-level, the caller in a high cost locale avoids having to pay the significantly higher charge for originating an international

341

call, the high cost carrier loses some toll revenues and the carrier in the country where second dial tone is generated handles more outbound international calls thereby accruing some additional switched toll or private line service revenues.

At the macro-level, the transaction can contribute to an expanding accounting rate deficit for the nation where the second dialtone originates. Callback operators provide dialtone from nations with low outbound international service rates, the key factor for generating an accounting rate deficit. By generating additional international message telephone traffic usage, callback operators will blunt somewhat the high cost carrier's revenue losses and the low cost carrier's revenue gains, because such calling triggers an accounting rate settlement and the likely transfer of currency from the second dialtone providing carrier to the original dialtone providing carrier.

Accounting Rate Fundamentals

Routing international telecommunications traffic involves a contract negotiated between carriers for each type of service between each pair of nations. Such bilateral arrangements promote multilateral collaboration in transmission facility investment.

International carriers jointly own, operate and maintain international submarine cables through consortia, and international satellites through cooperatives like INTELSAT.[4] Typically, ownership interests are allocated as a function of anticipated use. Joint ownership means that most carriers incur roughly the same cost per unit of international capacity. It follows that most parallel routes to the same region of the world would have roughly the same total costs, even though expenses for the domestic haul portion of a complete route can vary as a function of equipment vintage and traffic volumes.

A key component to international traffic routing are the financial terms and conditions under which carriers compensate each other for agreeing to match international circuits and to provide necessary switching and domestic routing necessary to deliver calls to the intended recipient. An accounting rate serves as the basis for dividing the toll charges[5] collected for the joint provision of an international service.

Accounting rates are negotiated by the participating carriers and have two components:

1) the unit of currency used and the applicable rate per unit of traffic carried, e.g., in 1991, United States International Service Carriers ("USISCs") and France Telecom divided 1.0 International Monetary Fund Special Drawing Rights ($1.42) per minute of full rate international message telephone service ("IMTS") traffic between the U.S. and France; and

2) the settlement process--how the accounting rate amount will be divided between correspondents, usually 50/50 when two carriers participate.

Carriers establish accounting rates to represent the total cost generally incurred to establish a complete international circuit, i.e., both international half-circuits and both domestic tail circuits to and from the international gateways. However, the FCC has concluded that "accounting rates for . . . IMTS are significantly greater than the current costs of providing service." [6]

Disparity between accounting rates and actual routing costs would have little significance if there were parity in traffic volumes from and to natons. Accounting rates have great significance when an imbalance of traffic streams exists, and substantial funds must be transferred as is the case for IMTS between the United States and many nations, both developed and developing. Likewise, accounting rates deviate from appropriately compensating a carrier correspondent when beneficiaries of traffic imbalances grow to rely on the hard currencies generated by such imbalances and the rate rates used to settle accounts.

Comparatively low IMTS rates in the United States have stimulated outbound IMTS calling, resulting in traffic volumes far in excess of inbound flows. Typically, the IMTS rates in most nations vastly exceed carrier cost and the equivalent outbound United States rate to callers, thereby dampening demand for inbound U.S. calling. [7] Many international carriers have viewed accounting rate surpluses as a painless way to subsidize below cost provisioning of postal and domestic telecommunication services.

Artificially high accounting rates, which have not dropped commensurately with reduced costs per unit of capacity, require net debtor carriers to make even higher settlement payments to compensate for the disparity in traffic volumes. It appears that despite increasing outpayment, USISCs have not found a way to achieve significant accounting rate reductions. Such high accounting rates do not necessarily reflect "whipsawing" of USISCs by leveraging inbound U.S. traffic to secure concessions.

The problem reflects asymmetry in the industrial structure of international telecommunications: only in nations with facilities-based competition, or a liberal policy on the resale of leased lines, do conditions favor efforts by a carrier to reduce accounting rates to cost. Absent such competition or an ability by users to migrate traffic from high cost to low cost call origination points, accounting rates will remain stuck at high levels.

Accordingly, the pace of downward pressure depends on how many nations authorize multiple international carriers and the market infiltration of callback operators and other players who can route traffic via an intermediate point at lower end users rates, despite multiple legs and possibly circuitous routing.

How Companies Avoid Accounting Rate Liability

Because accounting rates remain at artificially high levels for many routes, both new call back operators and incumbent carriers have exploited technological options to evade accounting rate liability. These carriers apparently benefit by operating in a "grey market" and providing limited access to low cost alternatives, rather than dismantling the accounting rate regime and providing lower, cost-based services to all users.

The call back operator can offer quite profitable services simply by slightly underpricing the incumbent carriers' rates that provide a price ceiling or umbrella. The incumbent carrier reluctantly will evade the very accounting rates it negotiated if necessary to retain high volume customers.

To avoid claims of discrimination or accounting rate violations, incumbent carriers characterize the discounted services as new offering that typically involve software controlled access to Public Switched Telephone Network ("PSTN") facilities partitioned for "private line" use by a single large volume subscriber. These options may violate ITU recommendations [8] and preexisting carrier tariffs, because they enable end-users to secure services in a manner inconsistent with the terms and conditions of the Old World Order Operating Agreements.

While such "bypass" may expedite reforms, it flouts uniform rules of the road. For example, the ITU Recommendations on leased international private lines contemplate the consultation and agreement on the scope of service. Private lines by definition provide intra-corporate or closed user group networking capabilities, not the functional equivalent to switched public, long distance services. However, some callback operators seek to deem any customer, no matter how dissimilar with other customers, as a member of a single closed user group.

What is occurring in international telecommunications parallels the grey market in international commercial aviation where carriers look the other way, or clandestinely collaborate with ticket resellers, consolidators and brokers who offer seats at rates well below the published tariff. [9] In international telecommunications, sophisticated users and system integrators can design private line networks that avoid accounting rate liability.

Carriers originally offered unmetered private lines as a way to fill up excess capacity and satisfy large volume user requirements for closed, internal networks. Private branch exchanges and other customer-controlled equipment have enabled users to interconnect unmetered international private lines with local public switched telephone networks. Such "leakiness" enables the private line subscriber to access users outside the internal network.

Expanded access to a private line "network" and regional traffic aggregation at switching hubs, means that users, who otherwise would have to use IMTS circuits, can opt for specially configured private line access for functionally equivalent service. Resellers can expand the reach of leaky private lines with higher capacity switches.

Some carriers and their regulatory overseers do not object to this type of "pure resale" that does not enhance leased lines. Resale stimulates overall capacity demand, and it can reduce outbound IMTS accounting rate liability, particularly where regulatory policies block or limit inbound resale. Some carriers, intent on capturing larger market shares by aggregating and routing regional traffic through a hub, may engineer a complex array of private lines and acquire both half-circuits on routes to handle accounting rate exempt traffic. Transiting, the routing of traffic destined for another country across domestic facilities, presents another opportunity for carriers and new international telephone entrepreneurs alike to engineer innovative new arrangements for users.

The State Department and FCC Confront the Call-Back Issue

Recently both the FCC and the State Department officially confronted the call back issue. The Department of State officially expressed its views in a letter from Ambassador Vonya B. McCann to FCC Chairman Reed Hundt on March 22, 1995. The letter stated the view that no treaty or general concept of law obligate the United States to "require that §214 authorizations for call-back configurations be denied or licenses revoked upon assertion by foreign carriers that call-back operators operating in the United States are violating their countries' laws. "[10]

The Letter also stated that the United States had made no commitment in any ITU forum to prohibit call back services: "In sum, we did not undertake any obligation in ratifying the Melbourne Agreement [which modified the ITU's International Regulations to account for developments in telecommunication services] that would obligate the United States (or any other Member) to consider the call-back configuration an 'international telecommunication service' regulated by the Melbourne Agreement or to enforce foreign laws regarding call-back."[11].

The FCC has not been as absolute in its consideration whether international obligations require some accommodation of foreign laws and policies. In an order granting reseller authorization to a call back operator, the FCC identified three requirements for any operator to be considered legitimate:

1) acquisition of Section 214 authorization;

2) filing a tariff; and

3) providing call-back service in a manner that is consistent with the laws of countries in which they operate.[12]

These conditions significantly limited the geographical scope of legitimate call back operations as the Commission has to balance its procompetitive regulatory and policy initiatives with its more conservative conceptualization of international comity. The FCC defines international comity as "the mutual recognition and accommodation by nations of their differing philosophies, policies and laws."[13]

In application this means that the Commission will not authorize call back operations for service to where nations have legislated an express prohibition. On the other hand, it will not serve as an agent for foreign carriers who simply want the FCC to eliminate a grey market competitor without taking affirmative steps themselves to prohibit such operations. While some nations may view callback operations as a threat to the incumbent carrier and cross-subsidies used to underwrite local telecommunication and postal services, other nations, which include Argentina and Hong Kong,[14] support callback as a way to normalize accounting rates and to stimulate competition.

The Commission expressly held that its authorization of applicants "does not address the legality of the proposed activities under foreign law which is a matter for foreign authorities and courts to decide."[15] However, the Commission will consider the existence of foreign legislation prohibiting call back services as sufficient grounds for denying a Section 214 authorization.

International comity requires sovereign nations--and their administrative agencies--to achieve mutual accommodation of perhaps different laws, policies, and regulations. But this accommodation requires only that nations "recognize rights acquired under the laws of another state . . .'so far as they do not cause prejudice to the power or rights of such government or of their subject.'" [16] It "is the recognition which one nation allows within its territory to the legislative, executive, or judicial actions of another nation, having due regard both to international duty and convenience, and to the rights of its own citizens or of other persons who are under the protection of its laws." [17]

The extraterritorial extension of foreign law to U.S. international resellers would usurp United States law and would bolster efforts by nations to block international resale, attempts by the United States and other nations to encourage carriers to negotiate accounting rates downward to cost and the Commission's long-standing efforts to promote competition in international telecommunications.

The State Department letter expressly freed the FCC of any absolute duty to extend the reach of foreign law in view of the inconsistency and potential harm that would result from such extraterritorial application of foreign laws. Arguably the Commission would act beyond its authority if it were to accept a foreign government's invitation to foreclose telecommunication activities that it previously has deemed lawful. The Restatement (Third) of the Foreign Relations Law of the United States provides that this nation may not exercise extraterritorial jurisdiction which is unreasonable.[18]

International comity and law require that nations respect differences and not expect or demand that other nations follow their lead as to any particular law or policy. Just as the Commission cannot expect all nations to adopt its procompetitive initiatives, including international simple resale, other nations cannot expect the Commission to abandon its policies and regulations simply because they present a conflict.

Nevertheless, the Commission's view of international comity may severely constrain legal U.S. call back operations if increasing numbers of nations outlaw the service. While expressing its belief "that foreign government which have decided to outlaw uncompleted call signaling bear the principal responsibility for enforcing their domestic laws," [19]the Commission will prohibit carriers under its jurisdiction "from providing this offering in countries where it is expressly prohibited." [20]

The Potential for Anarchy Leading to a New World Order

Even if nations outlaw international call back operations, such ventures may continue to exist in a" black" instead of gray market. The "real problem is not the accounting rate system per se, . . . [but] regulatory and licensing policies . . . [that] have inhibited competition . . . [thereby] buttress[ing] high and static accounting rates." [21] The incentive to retain high accounting rates can last only so long as the incumbent international carrier faces no competition at home. Should a government authorize facilities-based or resale competition for conventional telephone services, the second carrier might project revenue gains by reducing enduser charges and accounting rates to stimulate demand, and possibly to encourage USISCs to route more inbound traffic its way.

Despite the keen attention to privatization, and liberalization, most countries still reserve a monopoly for switched IMTS. The incumbent carrier may have become privatized and more flexible, but in most nations it likely retains a voice services monopoly.

In the absence of mandated "actual competition," either through resellers, or facilities-based carriers, call back operators provide "virtual competition." Real financial benefits accrue to users and real incentives to reduce accounting rates exist. But the call back operator may lack legitimacy, and in an increasing number of countries its very existence has been considered illegal.[22]

Accounting rates have remained artificially high, because United States and carriers in other nations have not identified mutually advantageous financial opportunities for changing the status quo. Unless traffic volumes move toward parity between outbound and inbound directions, one carrier will have every incentive to maintain high accounting rates as the factor used to compensate it for terminating more traffic than it originated.

Heretofore, the United States has disproportionately borne the burden of high accounting rates. But even in the absence of procompetitive initiatives, many countries and carriers may soon share the financial penalties. Creative routing techniques and facilities-based carrier competition already have begun to remedy the refusal of certain carriers to begin reducing accounting rates.

Conclusion

International carriers have quicker and less messy options available, such as committing to a multi-year transition to cost-based accounting rates. It remains to be seen whether they will pursue them without regulatory agency intervention, or the self-help of end users who resort to callback options or liberal interpretations of what constitutes permissible use of private lines by a closed user group.

Likewise, it remains unclear what regulatory incentives can stimulate downward pressure on accounting rates without stifling flexibility and innovation in carrier-to-carrier traffic routing and revenue sharing negotiations.

NOTES

1. For a complete history of accounting rate regulation by the Federal Communications Commission, see R. Frieden, "International Toll Revenue Division: Tackling the Inequities and Inefficiencies," 17 Telecommunications Policy No. 3, 221-233 (April, 1993); L. Johnson, "Dealing With Monopoly In International Telephone Service: A U.S. Perspective," 4 Information Economics and Policy 225-247 (1989/91); K. Cheong and M. Mullins, "International Telephone Service Imbalances Accounting Rates and Regulatory Policy, 15 Telecommunications Policy No. 3, 107-118 (April, 1991); and K. Stanley, "Balance of Payments Deficits, aand Subsidies in International Communications Services: A New Challenge to Regulation, 43 Administrative Law Review 411-438 (Summer, 1991); R. Frieden, "Accounting Rates: The Business of International Telecommunications and the Incentive to Cheat," 43 Federal Communications Law Journal No. 2 111-139 (April, 1991).

2. See Gene Retske, The International CallBack Book--An Insider's View, (New York: Flaitiron Publishing, Inc. 1995).

3. In its most simple form, code calling involves the assignment of a unique telephone number or code to each subscriber. When the subscriber wants to make an international call, he or she dials a local or international telephone number and hangs up after two or more rings. A switch or Private Branch Exchange also know as a "boomerang box" receives the call and is able to consult a database of subscriber identities and telephone numbers as a function of having received a call to a particular number. After determining who seeks calling access the boomerang box delivers long distance dial tone to the calling party and generates a billing record.

4. The International Telecommunications Satellite Organization ("INTELSAT") is a global cooperative, formed by an inter-governmental agreement, with a mission of providing ubiquitous satellite communications service. See Multinational Communication Satellite System, opened for signature Aug. 20, 1994, 15 U.S.T. 1705, 514 U.N.T.S. 26 (19 nation agreement establishing interim arrangements for a global satellite cooperative); Agreement Relating to the International Telecommunications Satellite Organization ("INTELSAT"), opened for signature Aug. 20, 1971, 23 U.S.T. 3813, 1220 U.N.T.S. 21 (INTELSAT Agreement); Operating Agreement Relating to the International Telecommunications Satellite Organization ("INTELSAT"), opened for signature Aug. 20, 1971, 23 U.S.T. 4091, 1220 U.N.T.S. 149.

5. The accounting rate does not necessarily equal the rate charged end users. This "collection rate" may be lower, as is the case for some outbound United States calls, but typically exceeds the accounting rate, in many nations.

6. K. Stanley, Federal Communications Commission, Common Carrier Bureau, Industry Analysis Div., The Balance of Payments Deficit in International Telecommunications Services, 19 (Dec. 12, 1988).

7. See Regulation of International Accounting Rates, CC Docket No. 90-337, Phase II, Further Notice of Proposed Rulemaking, 6 FCC Rcd, 3434, 3436 (1992) [hereinafter cited as Accounting Rate Phase II First Proposed Rulemaking].

8. Recommendation D.1, Sec. 7.1.1 of the ITU's International Telegraph and Telephone Consultative Committee Blue Book, Vol. II, Fascicle II.1, General Tariff Principles, Charging and Accounting in International Telecommunications Services, suggested that administrations can condition, consult and agree to the scope of access to public networks provided to users of international private leased circuits. To the extent that a private line reseller or end-user does not engage in such consultation and erects a system for accounting rate evasion, then the host country may deny access to the PSTN. However, in many instances accounting rate avoidance schemes may go undetected by the carrier providing interconnection.

9. International carriers do provide discounted rates to high volume users, e.g., as an incentive to migrate from unmetered private lines to metered "virtual" (software defined) private lines using the public switched network. The carriers avoid application of artificially high accounting rates by creating a new service category and applying a different, and lower,

accounting rate. These carriers typically have no obligation to justify how the new rate does not discriminate against users paying higher charges for existing offerings subject to accounting rates.

10. Letter from Ambassador Vonya B. McCann, United States Coordinator International Communications and Information Policy, United States Department of State to Chairman Reed Hundt, Chairman, Federal Communications Commission at p. 4 (March 22, 1995).

11. Id. at 3; See also id. n.10, p. 9 discussing the extent to which ITU regulations require extraterritorial application of domestic law and stating that "the United States and like-minded countries refused to bind themselves in Art. 1.7 or elsewhere in the Melbourne Agreement to enforcing the domestic laws of other ITU Members."

12. "Nor would comity require that §214 applications for call-back configurations be denied or licenses revoked upon assertion by foreign carriers that call-back operators operating in the United States are violating their countries' laws." VIA USA, Ltd., 9 FCC Rcd. 2288, 2292 (1994).

13. Regulatory Policies and International Telecommunications, CC Docket No. 86-494, Notice of Inquiry and Proposed Rulemaking, 2 FCC Rcd. 1022, para. 52 (1987). See also Regulatory Policies and International Telecommunications, CC Docket No. 86-494, Notice of Inquiry and Proposed Rulemaking, 2 FCC Rcd. 1022, para. 52 (1987).

14. See VIA USA, Ltd. Telegroup, Inc. Applications for Authority Under Section 214 of the Communications Act of 1934, as amended, to operate as International Resale Carriers; FCC 95-224, 1995 FCC LEXIS 3986; 78 Rad. Reg. 2d (P & F) 810 FCC 95-224, Order on Recon., at n. 61 (rel. June 15, 1995)[hereinafter cited as Callback Reconsideration].

15. Id.

16. Ernest G. Lorenzen, Huber's De Conflictu Legum, 12 ILL. REV. 375, 378 (1919) (quoting Huber), reprinted in Ernest G. Lorenzen, Selected Articles on the Conflict of Laws 136, 138-39 (1947).

17. Hilton v. Guyot, 159 U.S. 113. 163-64 (1895) (establishing principles of comity in determining whether to enforce a French judgment for the price of a shipment of gloves).

18. Restatement (Third) of the Foreign Relations Law of the United States, Sec. 403 (1992)(extraterritorial application of foreign law must be reasonable in terms of a balancing test that considers connection between the activity and territory, the connection between the parties and the nation; the importance of the regulation; justified expectations of the parties, etc.).

19. Callback Reconsideration at ¶ 50.

20. Id.

21. International Telephone Service Imbalances at 117.

22. The FCC's Callback Reconsideration identifies Mexico, Thailand, Costa Rica, the Philippines, Venezuela, Belize, Bolivia, Columbia, Czech Republic, Ecuador, Panama and Peru as nations, opposed to callback, that have taken some type of administrative step to declare it illegal. See Callback Reconsideration at ¶¶ 42 and corresponding notes 62-64; see also Philippine Long Distance Telephone Company v. International Discount Telecommunications, Formal Complain, File No. E-95-31 (filed May 11, 1995)(formal complaint against callback operator allegedly providing prohibited services to users in the Philippines).

TELKOM INDONESIA: A STRATEGY BETWEEN NETWORK-BASED AND SERVICE-BASED EXPANSION

B. Widjajanto, Agung Sutanto, Dodo Rukandi, Supriyo, Endang Susilowati and Sapri Sutisna
TELKOM Indonesia - IT Research Center
Bandung, Indonesia

1. ABSTRACT

TELKOM has achieved some success in expanding and modernising Indonesia's public telephone network. Efforts have been centered on three main goals: expanding customer access, modernising public networks, and introducing advanced services. This paper will outline TELKOM's strategy for expanding customer access, particularly in rural areas, TMN deployment to gain more control and management over networks and the introduction of IN in order to satisfy the demand from business customers.

2. BACKGROUND

The recognition of telecommunications as a fundamental infrastructure for promoting economic and social development has led to a new emphasis on expanding the scale, quality and scope of telecommunications services in Indonesia.

Since 1987, for instance, TELKOM has exceeded two of the three thresholds, US$ 750 revenue per line and 40% of revenue reinvested in the network, established by the International Telecommunication Union as preconditions for rapid expansion of the domestic telecommunications network. Indonesia is on target to reach the last threshold, telecommunications revenue as 1.5% GDP, with telecommunications revenue contributing 1.1% of Indonesian GDP in 1991.

TELKOM has achieved great success in expanding and modernising Indonesia's public telephone network. To meet the customer needs and be a competitive service provider in the future, however, TELKOM will have to harness the advantages offered by new telecommunications technologies. At the same time, TELKOM must continue expanding the capacity and improving the quality of the public telephone network.

After reviewing TELKOM's efforts, this paper will briefly examine TELKOM's strategy in expanding customer access to quality telecommunications particularly in rural and difficult-to-service areas which need high investment support with relatively low traffic per subscriber line, and where there is the least service penetration. The growth of digital technology within the telecommunication network in Indonesia has highlighted the needs of having a network management technique to achieve optimum availability and control of the entire network. On the other hand, TELKOM is attempting to satisfy the individual needs of its commercial customers by deploying new advanced technologies and diversifying its service base.

3. TELKOM's EFFORTS TO EXPAND ITS NETWORK AND SERVICE BASE

TELKOM's efforts in the last decade have been centered on achieving three main goals:

a. expanding customer access,
b. modernising the public telephone network to improve the quality of basic telephone services and commercial telecommunications,
c. Planning and implementing advanced telecommunications services.

3.1 Expanding Customer Access to Quality Telecommunication

TELKOM has attempted to increase telephone subscriber density and simultaneously to improve service quality. In the last decade, Indonesia has increased the number of telephone lines available by five times from 500,203 in 1983 to nearly 2,600,000 in 1993. Most of this growth has occurred in the last five years. For example, approximately 600,000 new lines were installed in 1992 compared to only 70,000 in 1987. TELKOM's goal is to add approximately 800,000 new lines in 1993 with 1 million additional lines every year thereafter.

TELKOM has also introduced fiber into the local loop in order to improve its performance. The pilot project has been progressing since 1995 and will be masively deployed in major cities, such as Jakarta, in 1996.

It seems that TELKOM will maintain the fast growth of its lines as the government has announced that the installation of five-million additional lines within the next five-year development program is considered as a top priority. Some parts of this network expansion will come along with the KSO (Joint Operating Scheme) program where private sectors were invited to build and operate telecommunication services in Indonesia.

This rapid growth in line capacity has helped to more than quadruple subscriber density levels from 0.44 lines per 100 inhabitants in 1987 to 1.89 lines per 100 inhabitants at the end of 1994. However, Indonesia's telephone density is concentrated in the most populous cities, such as Jakarta (14 lines per 100 inhabitants), Surabaya (10 lines per 100 inhabitants) and Bandung (7.5 lines per 100 inhabitants).

Realising the fact that service penetration in the outmost area is still low, efforts to achieve this first goal currently are being concentrated on providing basic telephone access across the archipelago with service to governmental administrative centers as a priority. All 27 of Indonesia's provincial capitals have long been connected to the national network since the launch of Palapa satellite system in 1976, while the next layer of government administration, 243 regions and municipalities, was connected in December 1991.

As with the regional capitals, the lower levels of governmental administration are also sometimes located in remote and difficult-to-service areas. Current efforts are being directed to connecting all of the administrative centers of the sub-districts in the regions. By December 1992, 714 of the 3636 sub-district capitals had automatic exchanges, 1510 sub-district capitals had manual telephone switches, while 1412 sub-district capitals have not yet been connected to the national network. TELKOM aims to connect all of the sub-district capitals with automatic telecommunication facilities in the next few years.

Extending conductivity to the centers of the lowest level of government administration, the desa or village, remains a difficult task. The area of a desa may vary from as little as ten square kilometres to more than 200 square kilometres. Desa may also contain many settlements or kampung in barely accessible terrain such as dense jungle, rugged mountains or spongy swamps.
TELKOM has been giving emphasis to the development of a telecommunication infrastructure in those remote areas. However, since it requires a large investment for establishing telecommunications services in the rural area with a relatively low return of investment, sound and effective planning will be of crucial importance, and a suitable network planning method supported by computerised data processing should be applied.

3.2 Modernizing the Public Telephone Network to Improve the Quality of Basic Telephone Services and Commercial Telecommunications

Activities to achieve this second goal have focused on upgrading the transmission and switching capabilities of the public network. With only 18% national call successful ratio in 1990, TELKOM has moved rapidly to modernise its telephone network by installing optical fiber trunks and digital exchanges. Nearly 60% of the national network became digital in 1993 with a full digitalisation of the network expected to be completed by 2005. In addition, TELKOM has launched a "back to basics" maintenance program for outside plant, equipment and local installations to reduce faults in the local loop.

Upgrading of the transmission and switching functions in the network has also allowed TELKOM to position its operation to flexibly take advantage of new telecommunication technologies. For instance, TELKOM was able to launch ISDN service, introduce signalling system 7 and prepare SDH implementation in anticipation of future customer requirements for new services.

With a quite high penetration of digital technology in its network, TELKOM was seeking a network management technique to achieve optimum availability and control of the entire network. Therefore, since 1993, TELKOM has introduced the telecommunication management network (TMN), a new layer in telecommunication infrastructure which is responsible for efficiently and effectively managing telecommunication network nodes from a centralised and integrated location. TELKOM's TMN plays a very important role in real-time monitoring on network status, minimising the effects of any network overload or failure by applying appropriate control and action over the network nodes, and determining the cause of network defects in order to ensure restoration in the shortest possible time.

The benefits of these modernisation efforts have been improved call completion, improved line quality and expanded customer features. The national successful call ratio increased to 35% in 1993 compared with 18% in 1990. The improvement of national call completion has begun satisfying customers.

3.3 Planning and Implementing Advanced Telecommunication Services

After achieving some success in expanding and modernising communications essential to government administration and commercial activities, TELKOM can now begin diversifying its service base. Progress toward the first two goals will continue, but TELKOM will now be able to address some of the more sophisticated telecommunications needs of business and institutional customers. For example, with the implementation of Intelligent Network services, TELKOM will be able to more flexibly provide customised services desired by individual business customers.

TELKOM began to offer narrow band ISDN in the third quarter of 1995 and will continue to offer specific N-ISDN based services given prevailing customer requirements and company resources. Some of the most promising N-ISDN applications for commercial customers include remote data communications and transfer. G4 fax and wide band (7 kHz) services will also provide customers with familiar services, but with more flexible features and a higher grade of quality.

Along with N-ISDN, TELKOM plans to commence Intelligent Network Services in early 1996. The five main services which will be introduced first are:

a. Advanced Freephone services (FreeCall)
b. Universal Access Number services (UniCall)
c. Calling Cards services (CreditCall)
d. Televoting services (VoteCall)
e. Virtual Private Network Services (NetCall)

The implementation of the FreeCall service will be given a high priority in response to the demand of business subscribers eager to promote their products and services. As UniCall allows the customer to have several terminating lines in any number of locations or zones which can be reached with a unique number, it gives the convenience to the customer of having a single directory number throughout the country. The CreditCall (this name can be misleading) gives the added convenience to the customer of making long distance or local calls from any terminal and paying the charge later through deposit accounts or through the bill of his/her telephone line at home. TELKOM will issue the calling card and Personal ID Number (PIN) to CreditCall customers. The VoteCall service enables public opinion to be surveyed, (for example, in a telequiz provided by TV or Radio stations) using a telephone network. Persons wishing to respond to an opinion poll can call advertised VoteCall numbers to register their call. NetCall permits the building of private network capabilities by using public network resources. It will allow TELKOM to flexibly package customised switching services to meet the dynamic voice connectivity needs of commercial customers who have a large number of lines. This service will also permit that type of customer to leave the operation and maintenance of their "private network" to the public telecommunication operator.

4. PLANNING AND DEVELOPMENT OF RURAL TELECOMMUNICATION SYSTEM

Indonesia is the largest archipelago in the world, stretching more than 5,000 km from east to west and about 2,000 km from north to south, and about 75% of its area is covered by water. The country consists of 17,508 islands of which only 7% are inhabited. From the geographical and demographical point of view, the major part of Indonesia can be classified as a rural area.

As line penetration in rural areas is very low, TELKOM has been concentrating on the development of the telecommunication infrastructure. However, rural telecommunication requires a high investment, and the return on the investment is low because of low traffic per subscriber. As a result, it is essential to have a sound strategy supported by appropriate planning tools.

4.1 General condition of Rural Areas

TELKOM categorises an area as rural if it has the following characteristics:

a. Population density is low compared with the urban area, while population distribution varies in each rural area (i.e., concentrated in a relatively narrow area, or scattered either individually or in small groups over a wide area).
b. Rural area may consist of lowland, hill country, islands or any combination of them;
c. It could be either economically developed or underdeveloped. The various employment

853

- opportunities which are available include agriculture, business, industry and tourism.

d. In several areas, economic development depends on the principal town in that area.

e. Economic activity is concentrated in only one or in several places, but it influences other places.

4.2 Rural Classification

TELKOM has been developing a method to classify rural areas based on geography, economic conditions, demography and other related factors. For simplified analysis and planning purposes, the rural areas in Indonesia are divided into three categories:

a. Type I (Concentrated Area)

This type is an area which has the potential to become a new urban area. The population density is relatively high and concentrated in a fairly small area with social facilities already existing and at an acceptable level.

b. Type II (Scattered Area)

This area surrounds an urban area with a population scattered around small groups. The population groups are relatively small and at a relatively long distance from an urban area. The economic activities, though limited in scale, are tending to grow and are generally dominated by agricultural production.
The geographical condition varies; several population groups are located in hill country, lowlands, islands or along riversides and roadsides.

c. Type III (Remote Area)

The population density is low and scattered individually over a wide area. Economically, this area is under-developed with relatively poor education facilities. Many remote locations are barely accessible due to difficult terrain that may consist of jungles, rugged mountains, spongy swamps, or isolated islands.

4.3 Technology Selection

The selection of technology for rural areas considers several aspects:

a. The technology must have the ability to serve all subscribers in planned rural areas.

b. It must be able to provide services for anticipated future subscribers in the intermediate and long term.

c. From an economic point of view, the technology applied must be the most cost-effective of all alternatives.

In view of the criteria mentioned above, the technologies for each rural type are:

a. Type I (Concentrated Area):
   1) Remote Switching Unit (RSU) with a multi-access radio or cable route system
   2) Rural Exchange with a multi-access radio system or cable route system

b. Type II (Scattered Area):
   1) RSU with a multi-access radio system or cable route system
   2) Concentrator with a multi-access radio or cable route system
   3) Line subscriber multiplexer

c. Type III (Remote Area):
   1) UHF or VHF radio link
   2) Very small earth station

4.4 Network Planning approach and methodology

For network planning purposes, a rural network covers an area in which most of the traffic is local, and the highest level in the switching hierarchy is a primary center. The rural area under consideration may consist of one or more than one of the types described above. The planning process covers the forecasting of demand and of traffic, the design of the network structure, the selection of a system and of technology, and the estimate of the cost. To guide the development of the infrastructure, it is essential to plan for up to 15 years in the future. The rural area is divided into sub-areas called communes, consisting of several villages. The definition of commune area is based on economic activities. Each commune has a commune center (big village) where the economic activity is concentrated; this commune center provides facilities to serve economic activities in other villages.

There are great differences between villages regarding population size, administrative and cultural levels, socio-economic types, private economic levels, and population development trends. For simplification, the villages are divided into several categories (village categories), each category having a specific parameter for forecasting both demand and traffic. The main forecast parameters are: density (D), calling rate (CR), proportional internal traffic(PI), proportional out-going traffic (PO).

854

The objectives of forecasting are:

a. to define the number of subscribers (main lines), the originating traffic, terminating traffic and internal traffic for each village;

b. to define traffic interests between each commune;

c. to define long distance traffic from and to each commune.

Village categorisation is based on five major parameters which use the acronym **SLEPT**; **S**ize is the population figure. **L**evel indicates which function the village provides (i.e.: almost no functions, basic-police, fire fighting, medical center, elementary school, many functions for own day-to-day needs, administrative and commercial centre for other towns, administrative and commercial centre for a large area). **E**conomy is the major economic activity (i.e. agriculture, fishing, small industries, large industries, business, administration). **P**rivate refers to the economic level of the population (poor, average, high) and population development **T**rend (i.e.: rapidly decreasing, slowly decreasing, constant, slowly increasing, rapidly increasing). The data required to define the village parameter for the past and present time are available, while for the future these parameters are estimated (forecasted) based on the development plan and other related plans.

The process of forecasting and optimising the network, which is carried out by software planning tools, enables us to create a network which can cope with demand at an optimum cost.

5. THE ROLE OF NEW TECHNOLOGY IN IMPROVING THE QUALITY OF SERVICE

5.1 Telecommunication Management Network

The administration, monitoring and operations of the telecommunications network is becoming a very complex task and requires the application of a network management technique to achieve optimum availability and control of the entire network. Network management is the function of supervising the performance of the network and taking the necessary action to control the flow of traffic in order to maintain a high level of network element utilisation and to minimise the effects of network overloads.

After a long observation and analysis of the network, in 1993 TELKOM decided to adopt the Telecommunication Management Network which enabled the company to achieve more efficient, effective, centralised supervision over the network compared with the existing localised and separated network management. With the launching of TMN, TELKOM expected to achieve optimum availability and control of the entire network, to have the capability to monitor the performance of the entire network and to facilitate planning for anticipating peak traffic periods which together improve quality of service for the customers.

Telecommunication Management Network Structure

The prime infrastructure of the Network Management function is the Integrated Management System (IMS) presently being installed in Indonesia. This system is expected to be capable of achieving certain functions of the ITU-T (formerly CCITT) Telecommunication Management Network as per draft recommendation M.3010. These functions should include fault management, configuration management and performance management as defined in the CCITT TMN business model.

The network management function is a two-level hierarchical organisation, centered on the National Network Control Center (NNCC), which falls under the control of the Directorate of Operations and Marketing in the TELKOM Headquarters. The Second level of the organisation is the Regional Control Centers (RNCCs), which are at the regional administration (WITELs). This second level organisation comprises five regional centers which are located in Jakarta, Surabaya, Medan, Balikpapan and Ujung Pandang.

The NNCC carries out surveillance of the overall network and transmission backbone. The RNCCs, which are connected to the NNCC, carry out surveillance of switching in each region. This configuration ensures an integrated approach to minimising network problems affecting any other part of the network. Information on network performance is sent from network elements to the NNCC or the appropriate RNCC, where it is displayed on screens or network maps, giving the staff at a particular center the means to quickly observe, analyse and react to network failures. Since early 1993, IMS has been performing the network element management function with the main tasks of controlling and maintaining the switching and transmission system. For switching surveillance it is equipped with an operating system that can improve operations by providing a means for detecting problems before the customers become aware of them. For transmission surveillance, IMS is equipped with cross-connects controller equipment which deals with monitoring, controlling and protecting transmission links such as digital and analogue microwave transmissions, Jakarta - Surabaya Fibre Optic Communication, satellite communication, PCM in Jakarta multi-exchange area, etc.

Since 1994, IMS has been performing network management functions such as traffic management with the capability of controlling dynamic routing. The traffic management carries out corrective actions that move traffic from a busy route to a non-busy route and preventive actions that prepare spare routes for alternative routing in an overloaded situation. It is also planned to implement a service management function into IMS by integrating available software.

During the two-year operation of IMS, TELKOM has increased the long distance answer call ratio (ASR) to 42.68% in 1994 compared with 27.67% in 1992, and it has also helped the growth of the long distance successful call ratio (SCR) to nearly 30% in 1994 compared with 22.21% in 1992.

Future Development of IMS

Although IMS has been performing a satisfactory task in monitoring network elements, TELKOM considers that it has not been optimally utilised during its two years of operation. For instance, the RNCCs and the NNCC are primarily designated as control centers; however, in reality, their main function is just as network surveillance centers. It was also noticed that only around 50.6% of network elements have been successfully integrated in the monitoring vehicle.

The objectives that drive TELKOM to optimise IMS functions include:

a. the forthcoming IMS should have the capability and flexibility to deal with the introduction of new services and network technology, such as Intelligent Network, ISDN (narrow ISDN and broad band ISDN), and new signalling system 7;

b. with the commencement of KSO (Joint Operating Scheme) in January 1996, IMS will be expected to cope with the rapid growth of the telecommunication network as the government of Indonesia has announced an additional five million new lines for the next five-year development program. Through KSO, private operators are invited to participate in the development and operation of the telecommunication network. Therefore Indonesia will have eight different networks, consisting of five regional operation networks under KSO (Sumatra, West Java, Central Java, Kalimantan, and Sulawesi-Maluku), and two regional operation networks run by TELKOM (Jakarta and East Java), and Divisi Network. This fragmentation needs the establishment of a new set of rules for IMS operation;

c. achieving the "world class operator" level that TELKOM's management has set as a target;

d. to implement the full set of capabilities that ITU-T has defined as per draft recommendation M.3010.

The evolution of TELKOM's IMS is divided into 4 stages, namely:

a. First stage (1995-1997) will be focused on the enhancement of the capabilities of the current system, and the implementation of the network operation process. The activities comprise: integrating all network elements into the IMS, centralising its network operations in the regional control centers and developing NNCC as the national crisis center for handling major problems that arise in the network.

b. In the second stage (1997-2000), IMS will be developed to support the customer contact service. The customer contact services will be developed by establishing a front office and a back office. The front office will be responsible for meeting the demands of business and residential customers via on-line transaction directly linked into the IMS. The back office will provide all the support systems to assist day-to-day operations of the company. The existing information system for cable administration, the SISKA, will be integrated into the IMS.

c. During the third stage (2000-2005), TELKOM should have already integrated the network and planning process and should reach World Class Operator level in 2001. Together, the IMS and SISKA can provide basic engineering and planning capabilities. The further development of this process is based on: 1) systems which are capable of automatically analysing market and network data, 2) developing network plans, 3) developing economic and architectural

856

alternatives, 4) providing information on additional services required in areas that make most economic sense.

d. In the fourth stage (2005-2010), accounting and corporate support systems are integrated into the IMS. The accounting system has facilities for automatic cost tracking, inventory control, general ledger accounting, direct collect payroll information, cost accounting, and direct interface with the billing and collection system. All of these systems mentioned above should be interfaced to a corporate information system to provide accurate and up-to-date information on all areas of the business and also the information required by the regulatory body, customers and suppliers.

5.2 Intelligent Network

The modular structure of the Intelligent Network which separates routing logic from the service logic, not only serves as an engine driving the telecoms service provisioning into the 21st century but also changes the nature of telecommunication as well. In the IN era, the regular telecoms service will be tailor-made to the individual needs and made available as and when required.

With almost 200 million Indonesian inhabitants scattered amongst 17,508 islands and a quite low service penetration, the centralised service provisioning that the Intelligent Network offers seems to be a promising solution. It will enhance service expansion, service diversity and service customisation. Some initial efforts have been made to deploy Intelligent Network services in TELKOM's network by early 1996.

Intelligent Network Infrastructure

The Intelligent Network infrastructure contains three main nodes:

a. Service Switching Point with an integrated Intelligent Peripheral

b. Service Control Point

c. Service Management Point with additional Service Creation Environment

Rather than services being "embedded" in the software of the exchanges, the service logic is held at a centralised point, known as an SCP. Thus, if a new service is required it is not necessary to update the software in all the exchanges (which may come from different vendors) but only to change the service logic in the SCP.

The SSP is a modified exchange which has the ability to recognise certain trigger conditions, for instance the dialling of specific digit string such as an advanced freephone number. When a trigger is recognised the SSP will suspend processing of the call, and send a query message to the service control point (SCP).

From the information contained in the query, the SCP will determine which service has been invoked and will execute the necessary service logic. The service logic when executed will gain access to data enabling it to find a network address. This translation may depend on several factors, such as the time of day and the caller's line entity. Once translation has been determined, the SCP will instruct the SSP to connect the call to the appropriate network address.

When service user interaction is required during the execution, the SCP may request the SSP to connect the user into an intelligent peripheral (IP). This provides service-specialised resources such as announcements and facilities for collecting digits from the end user.

The service management point (SMP) provides service-specific management functions. The SMP also acts as a master database. The service logic which provides the Advanced Freephone service is created using the service creation environment (SCE). The SCE allows for services to be built and tested in a prototyping environment. The new services will be tested, modified and given a limited trial in this controlled environment. Verification and modification may then be carried out. This inherently improves network security since a trial or prototype service can be segregated to an off-line environment. Once it has been decided to launch a new service, the service logic is downloaded to the live SCP via the SMP, for use by customers. The protocols used between the SCP via the SMP and IP have been defined by both ETSI and ITU.

Intelligent Network Deployment Plan

TELKOM plans to begin offering five Intelligent network services in early 1996. These Intelligent services will be supported by three SSP which will be installed in three main cities, namely, Jakarta, Surabaya and Medan. The SCP, which contains information related to subscriber services will be located in Jakarta.

The five main services which will be introduced first are:

Advanced Freephone Service (FreeCall). In the first implementation of the IN system, it will be possible to register at least 2,000 freephone subscriber telephone numbers, and it will be possible to expand up to 5,000 freephone subscribers according to the level of the demand.

Universal Access Number Service (UniCall). The database shall be able to register at least 2,000 UniCall initially and will also be expandable up to 5,000 UAN numbers.

Calling Card Service (CreditCall). The database for the Calling Card Service shall contain at least 10,000 card numbers initially and will be expandable up to 100,000 card numbers for the next step.

Televoting Service (VoteCall). Initially the database shall be able to register at least 1,000 Televoting subscribers and will be expandable to 2,500 televoting subscribers.

Private Virtual Network Services (NetCall). In the first launching, the IN system will allow up to 500 VPN networks to be set up. Within each private network, the subscriber base can range from 2 to 10,000 subscriber numbers. In the next implementation its capacity will be expanded up to 1,000 VPN networks, each private network having from 2 to 20,000 subscriber numbers.

The ITU-T recommendation CS 1, which ensures that services defined within IN structured environment will operate properly across equipment provided by multiple vendors, was just approved in June 1995. Therefore TELKOM's Intelligent Network can be considered as "pre-CS 1". However, in order to obtain the eventual inter-operability of the IN service, TELKOM adopted a set of standards defined by ETSI and known as ETSI Core INAP.

Since there is no common strategy in implementing a multi-vendor Intelligent Network and IN standardisation is still in progress, TELKOM expects that the maximum multi-vendor capability could be realised starting from the end of 1996. The path into multi-vendor IN then will be as follows:

a. SMP, SCEP, SMP and SSP are delivered by a single vendor as will be done in TELKOM project;
b. nodes (exchanges), in which implementable INAP functionality is embedded, may be delivered by different vendors.

Although INAP is available for a multi-vendor environment, experts in IN project still agree that interworking between IN equipment from different suppliers cannot be achieved without close co-ordination between TELKOM and manufacturers.

6. CONCLUSION

TELKOM has experienced a rapid growth of additional new lines which has helped increase the lines-inhabitants ratio during the past five years. It is apparent that telephone lines density in the most populous cities is much greater than in the outmost areas of Indonesia, and TELKOM should give emphasis to the development of the telecommunication infrastructure in remote or rural areas.

Since the development of the telecommunication infrastructure requires financial support with a quite low of return of investment, TELKOM has been developing a sound and effective plan using a suitable network planning method supported by computerised data processing.

On the other hand, the rapid introduction of new advanced network technologies in the telecommunication industry has provided the potential to lower costs, improve network quality and broaden the range of customer services. These global shifts in telecommunication technology have been coupled with an increasing demand for more diverse and sophisticated services. The Indonesian Government has responded by increasing the number of telecommunication providers for non-basic or value-added services. As a result, TELKOM now faces increased competition for its most profitable commercial and urban areas, while it still retains its responsibility to meet the needs of basic telephone services across the archipelago. TELKOM is working diligently to exploit the advantage of advanced network technologies in order to increase network performance and reduce costs of providing basic services. At the same time, implementing these technologies will allow TELKOM to provide a more diverse range of services that will satisfy its most profitable customers.

Cellular telephones and pagers in Hawaii: Cultural influences on personal use patterns

Dineh M. Davis
University of Hawaii at Manoa
Honolulu, Hawaii

1. ABSTRACT

A study of cellular telephone and pager users in Hawaii focuses on procurement and personal patterns of use for these mobile communication devices. Cultural and demographic factors are scrutinized for patterns that confirm or negate our stereotypical associations with these devices.

2. INTRODUCTION

Hawaii continues to lead the nation in its penetration rate for cellular telephones. Potential reasons for this phenomenon were noted in earlier studies (Davis, 1993a & 1993b) and include, among other factors, the lower than Continental U. S. average subscription rates, stronger interpersonal bonds among the residents, less privacy in extended family living conditions, the island residents' outdoor life-style, and the lack of opportunities for larger, more financially burdensome investments such as home ownership that potentially leave more disposable income available for such smaller & thus relatively more affordable "luxuries."

Regardless of the reasons for heavy use of pagers and cellular telephones in Hawaii, such abundance of "early adopters" of these technologies in the personal communication sector lends itself well to research opportunities. Learning more about the motivation and use patterns of individuals will allow us further opportunities for comparison with other forms of mediated communication. Additionally, tracking such use patterns may allow a more conscious path toward equitable use of such devices, discarding some of the old stereotypes and biases that become entangled in the adoption of new technologies. This paper explores some of the reasons why Hawaii's use patterns may be different and whether or not these are region-specific or a harbinger of what is to be expected in other geographic regions in future years. An analysis of surveys and interviews with Honolulu residents and UH-Manoa students yields some expected results as well as a few surprises.

3. LITERATURE SURVEY

Although historical and contextual references to diffusion of new communication technologies abound, their review is beyond the scope and limits of this paper. Non-proprietary research on personal use of cellular telephones and pagers is scant. Although the mobile telecommunication industry performs routine pilot studies and market research - especially in the area of Personal Communication Networks (PCNs) - most of the results remain proprietary. There is little published without industry funding and strictly in academic literature that focuses on personal rather than professional mobile communication. Recent interest has remained most notably with students in the field of communication and telecommunication in the United States and abroad. A brief bibliography notes some of the highlights in existing literature, focusing on research in the Asia/Pacific region.

4. RESEARCH QUESTIONS

My specific area of interest is the personal use of telecommunication devices as opposed to their work-based or professional applications. In this context, some of the questions that have intrigued me the most and their associated importance are as follows:

Question: Are there significant differences between the owner and nonowner populations of cellular telephones and pagers?
Importance: It is generally assumed that the market for cellular telephone and pager ownership will expand to include most of the adult population. The questions typically raised are more likely to be about how long it will take to reach market saturation and how much individuals are willing to pay for such service. My contention is that market penetration rates are tied to variables other than the affordability of the product and a universal human need to be "connected" at all times.

Therefore, studying the owner and nonowner populations could shed some light on some other fundamental differences between the two groups beyond the effects of market forces. If such differences correlate with human rather than market variables, it may not be as likely that such communication devices will become acceptable to everyone regardless of availability or cost factors.

Question: Are there significant gender differences in personal use of cellular telephones and pagers?
Importance: Academicians have argued that electronic communication media equalize the playing field for both sexes. Having access to such media will therefore break down existing sociocultural and economic barriers and make women equal partners with men in the twenty-first century. It is my observation that although electronic devices may become equally available to both sexes, existing sociocultural barriers will continue to dominate the new telemedia spaces, thus entrenching and spreading the status quo rather than overcoming them. The focus of the discussion is on the manifestations of similarities and differences in media use, rather than a debate on its underlying cause (be it nature or nurture).

Question: Are there significant differences among individuals from different ethnic backgrounds in their personal use of cellular telephones and pagers?
Importance: The critical importance of this question is partially related to the previous gender-based issues and partially related to the generalizability of the results of this study. On the former, it is important to separate ethnic, cultural customs from gender-based customs. Regarding the latter, if ethnicity is not a critical factor in cellular telephone and pager use then the Oahu-based study has a greater potential for generalizability than if significant differences are observed among various ethnicities.

5. METHODOLOGY

This study is the culmination of three years of data gathering and research on cellular telephones in Hawaii. The first study focused on highway safety and involved the study of over 900 police officers on Oahu (Davis, 1993). Personal interviews, computer-mediated discussions, and focus group sessions through the following two years led to the development and refinement of a survey instrument that sought to identify patterns of use for cellular telephones. In the interim, it became quite apparent that the pager-using population was also growing very rapidly and that many individuals owned both instruments and used them in unison on many occasions. The study was therefore expanded to include pager users as well. For the purposes of clarifying the data analysis and discussion sections of this paper, the use pattern questions are repeated at the beginning of the data analysis section.

In the winter and spring of 1995 a modified snowball technique was used to gain access to both owner and nonowner populations of varying backgrounds. Student volunteers were recruited and given uniform instructions on distributing, collecting and reviewing the survey instruments for authenticity, accuracy, and completeness. To gain the widest diversity in the sampled population, volunteers were asked to distribute the survey instruments away from campus in major shopping malls as well as among neighbors, co-workers, and extended family members. Simultaneously, the same instrument was distributed among two hundred upper division students in a geography class. Both samples were reviewed once more for completeness and consistency and were ultimately combined for data analysis purposes after chi-square and Kolmogorov-Smirnov tests revealed no significant differences in use patterns among the two sample groups at $p \leq .05$ level.

6. DATA ANALYSIS

Out of 400 survey forms collected, a total of 355 valid cases were analyzed for this study. Except for the analysis required for the first section below, and because of the statistically significant differences found in the use pattern between these two groups, the nonowners were separated from the sample population, reducing the total sample size studied to 272. The distribution of these device owners is displayed in Figure 1 and is as follows:

Category	N	% of Total Sample
Cellular telephone owners	183	67.28%
Subjects without cellular telephones	89	32.72 %
Pager owners	221	81.25%
Subjects without pagers	51	18.75%

Total owner population studied: 272
Total owner & nonowner subjects: 355

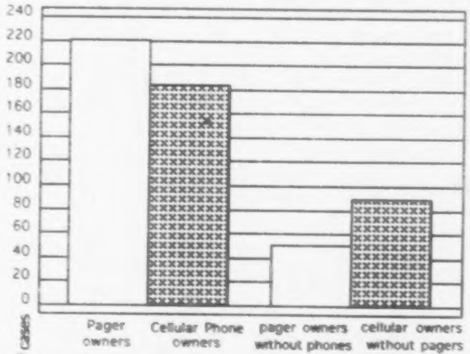


Figure 1 Distribution of ownership and overlap of ownership of cellular telephones & pagers in the sampled population

We can see, therefore, that 131 subjects or 48% of those surveyed owned both a cellular telephone and a pager. This is clearly a trend worth watching.

6.1 Patterns of use: One section of the questionnaire distributed to the sample population focuses on the use patterns for mobile communication devices. The section began with the statement:

My use (or past use) of a cellular telephone and/or pager for personal (non-business-related) purposes generally follows (or followed) this pattern:
On a 1 to 5 scale, circle the most appropriate number when:
1=Least likely reason 5= Most likely reason

This statement was followed by these use categories or suggestions:

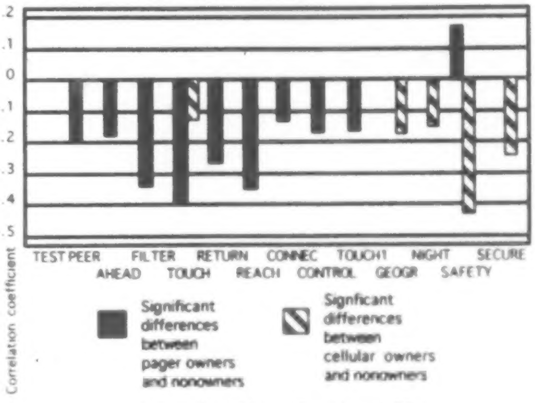
To "play" with or "test out "new technology
To be like most of my peers
To stay ahead of most of my friends
To filter (and potentially avoid) unwanted calls
To always stay in touch
To be in control of "if and when" I want to return calls
To let others reach me whenever they need me
To see what it is like to be more "connected"
To see what it is like to be more "in control"
To keep in touch with ONE particular person
To allow me greater freedom to go into geographically unknown areas
To allow me greater freedom in staying out late at night
To allow me greater personal safety
To provide my loved ones (significant others) more security

It is important to note the exact wording of each statement, especially the last one - referring to the security of "others" rather than oneself - when analyzing the data presented in the remainder of this paper.

6.2 Owners vs. Nonowner

As noted earlier, there were no significant differences (at p<.05) in demographics between the owner and nonowner populations sampled. Thirty nonowners, however, took the time to respond to potential patterns of use for these devices as though they owned one. A comparison of these respondents' self-reported perception of *potential* use patterns with the owners' self-report on *actual* use patterns reveals a number of significant differences which led to the separation of the original sample into two distinct populations: owners and nonowners. Therefore, the nonowner population was excluded from the remaining data analysis. Figure 2 displays these significant differences. This side-by-side comparison of pager owners and cellular owners clearly shows the effect of the inherent constraints or capabilities of each device, such as the lack of relevance of carrying a pager to a variable such as safety. The data also points to perceptual affinities toward stereotyping of mobile telecommunication devices for the nonowner community. This issue is further discussed in the sections that follow.

Figure 2. Significant differences between actual use and perceived use patterns for those who owned either cellular telephones, or pagers, or both devices and those who owned neither device.



Missing data deletion: Casewise. N=284.
Displaying only correlations significant at p< .05

6.3 Demographics

Each subject was asked to identify her or his sex, age, level of education, employment (or student status), as well as self-described racial or ethnic identity. No statistically significant difference in demographics was observed between owners and nonowners of pagers and cellular telephones in the sample studied, using Chi-square and T-test for independent samples. Other differences are as follows:

Age: In the cellular telephone owner population, there was a significant positive correlation (at respectively p<.01 and p<.001 levels) between the source of procurement of the device and the age and sex of the recipient. The majority (51.6%) of females under the age of 25 received their cellular telephones as gifts. This compares with 26.7% of young males and only 7.5% of men ages 25 and older receiving similar gifts. As can be seen in Figures 3-6 the procurement source of cellular telephones for women ages 25 and older is remarkably similar to that for men under the age of 25.

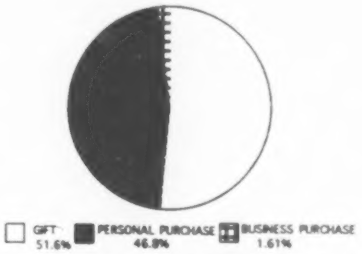


FIGURE3. SOURCE OF CELLULAR TELEPHONE PROCUREMENT FOR FEMALES UNDER THE AGE OF 25

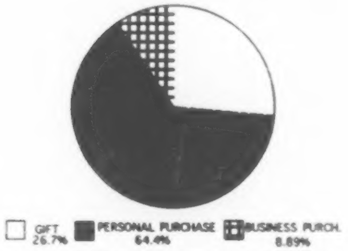


FIGURE 4. SOURCE OF CELLULAR TELEPHONE PROCUREMENT FOR MALES UNDER THE AGE OF 25

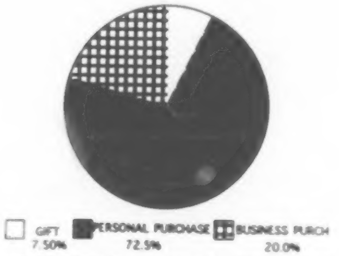


FIGURE 6. SOURCE OF CELLULAR TELEPHONE PROCUREMENT FOR MALES 25 YEARS OF AGE AND OLDER

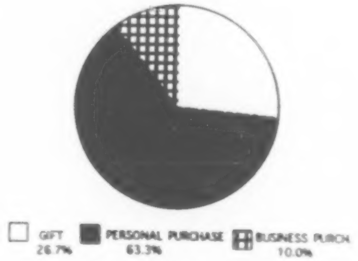


FIGURE 5. SOURCE OF CELLULAR TELEPHONE PROCUREMENT FOR FEMALES 25 YEARS OF AGE OR OLDER

Sex: In addition to positive correlations with receiving of cellular telephones as gifts, male/female differences are observed in many use patterns. For cellular telephone owners, women rate the statement "To allow me greater personal safety" at a significantly higher level than men (at p<.01 level). It is interesting to note that while for actual cellular telephone owners who are female the mean for the group is 4.15 for this question, for the female nonowners the mean jumps to an astonishing 4.9 (out of a maximum of 5) leading to the speculation that nonowners are responding on the basis of stereotypes rather than an internalized personal need for the device. For the same question, the mean response for male cellular telephone owners was 3.26 compared with 2.55 for nonowners. Again, the difference seems to be accentuated because of a cultural expectation that "men can take care of themselves" and don't really need an external "crutch" for safety.

Another area where gender differences appear is in the ranking of calls made on the cellular telephone. Since this study specifically sought to attract subjects who used mobile telecommunication devices for personal rather than professional reasons, it is both understandable and expected that both men and women would rank personal and social calls as first and foremost on their list. It is interesting to note, however, that women are reporting far fewer business related calls and men have a more evenly distributed use pattern, making a smaller number of emergency calls than women. Both usage differences are significant at *df*=1 and *p*<.01. See Figures 7 and 8.

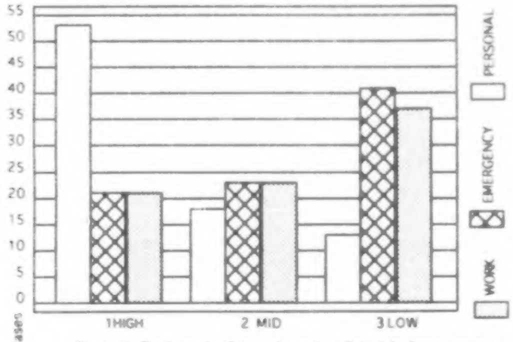


Figure 7 Ranking of call types by male cellular telephone owners

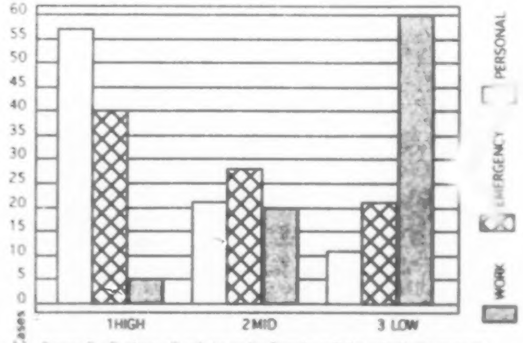


Figure 8. Ranking of call types by female cellular telephone owners

While no usage differences between the sexes are observed for pager owners, gender differences in use patterns in cellular ownership cases are significant in the area of safety and staying in touch. In addition, such differences are also significantly different for the owner vs. the nonowner sample population (see Figures 9 and 10).

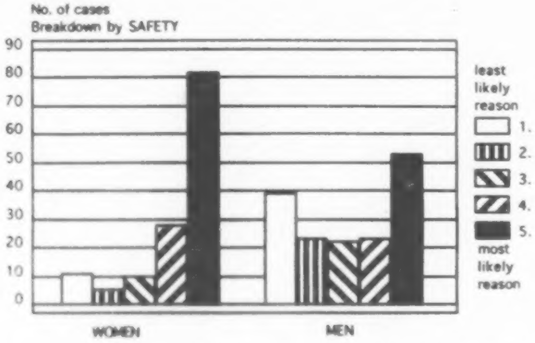


Figure 9 Safety as a reason for using cellular telephones: a gender comparison

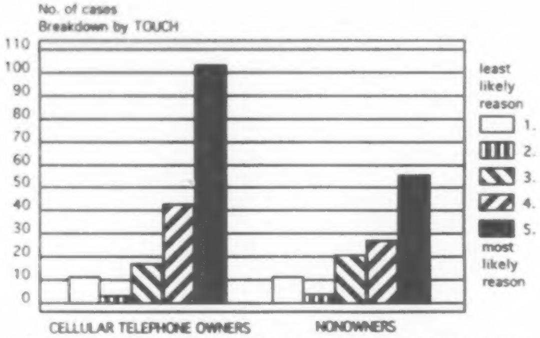


Figure 10 Keeping in touch as a reason for wanting to use cellular telephones
A comparison of perceptions by those who own and don't own a cellular phone

Ethnicity & race: For those who are familiar with Hawaii's residents, it is not difficult to understand that the ethnicity question poses enumerable problems because of the great diversity in the population and for the majority who identify with two or more ethnic groups or races. For this reason, it is extremely difficult to obtain a representative sample by ethnicity or to obtain a large enough sample in any given ethnic mix to carry out tests of significance. Several observations worth a "tentative" note here are as follows:

Caucasian and Hawaiian population comparison. A significantly higher Hawaiian population owns both cellular telephones and pagers when compared to the Caucasian portion of this sample. This, however, may be an anomaly based on the distribution mechanisms for the questionnaire and possibly the fact that Caucasians may have been conditioned to fill out forms even when they have little personal information to offer, whereas the Hawaiian nonowners may have hesitated to take the time to fill out a form for which they had little data; that is, when they did not have either a pager or cellular telephone. Although several significant differences were observed in the smaller data sets for Hawaiians and Filipinos, I would consider the sample size (38 and 42 respectively) to be too small for legitimate comparisons. However, in the case of the Japanese sample subset (with 110 subjects), the sample is large enough to allow for the reporting of the following differences which were not observed with any other ethnic group:

(1) Japanese men join all women in their significant need to "provide loved ones with security."

(2) Japanese women own a disproportionately higher number of cellular telephones when compared to the owner population as a whole; while Japanese men own a disproportionately smaller number of cellular telephones than the owner population as a whole.

6.4 Cellular Telephone Owners vs. Pager Owners

Clearly, we can intuitively associate pager ownership with the need to filter and control as well as to keep in touch, while cellular phone ownership is more stereotypically tied with the need to stay in touch and for safety. The figures in this study not only confirm these associations, but they go one step further; they show the cellular telephone owners as far less concerned with connectivity since the majority of the owners either have the phones turned off when not actively in use or have them off nearly all the time.

Cellular Telephone Owners: The sample was rather evenly divided between male and female representatives. Both personal safety issues and providing loved ones with more security were significantly linked to giving cellular phone numbers to "those who are very close to me." (Personal safety significance level at $p<.001$; and security at a probability level of $p<.01$). Figure 11 depicts the use pattern for cellular telephone owners focusing on the more outstanding pattern differences.

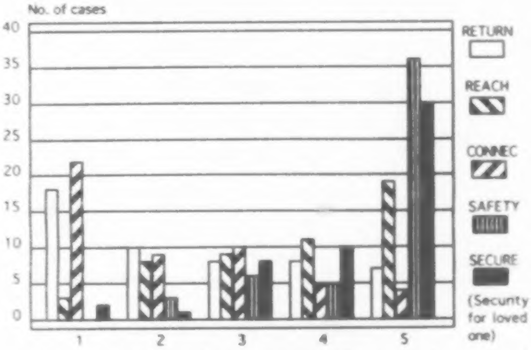


Figure 11. Cellular telephone owners (without pagers) identify the most important uses of cellular telephones

(Please refer to text for full description of labels)

Pager owners: Pager numbers were reported to be given out in the following distribution:

N	Categories of recipients of pager numbers
203	Those who are very close to me
128	Business associates
180	Relatives and acquaintances
108	Those to whom I would not give my home phone #
113	Anyone to whom I would give my home phone #
88	Those whose calls I wish to screen before deciding to speak to them

See Figure 12 use patterns of pagers. It is noteworthy that the only statistically significant difference ($p<.05$) between male and female users of cellular telephones and pagers was when a woman owned both instruments and, even then, only in the "safety" category.

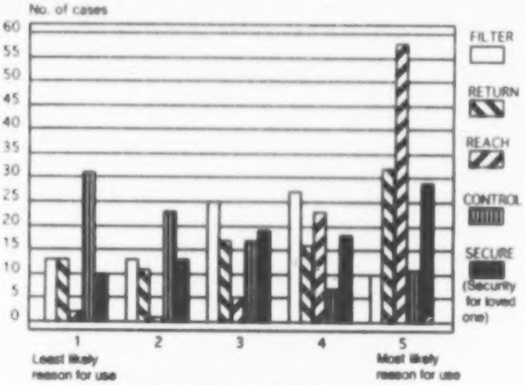


Figure 12. Pager owners (without cellulars) identify the most important uses of pagers

(Please refer to text for full description of labels)

7. DISCUSSION

Nearly half (48%) of the individuals who owned a personal mobile telecommunication device owned both a cellular telephone and a pager. This trend in itself is worth observing for those planning future mobile services. Although some of the reasons for carrying both devices is based purely on physical or technological constraints (that is, the relative stability, life-expectancy, and cost of batteries for the two devices as well as the relative bulk), another set of reasons is related to the cost of service and types of services offered by each company.

Although many questions were asked regarding the types of services the subscribers received from their respective service providers, it was interesting to note that most individuals were not keenly aware of the details of their subscription services. For example, Figure 13 displays the reported free air time provided with the cellular telephone owner's subscription. An additional 36 individuals were "aware" that they had free airtime, but had no idea of the actual number of minutes. Adding those individuals to the list, we find that only 69% of the population is aware of any free time that is available to them. In addition, many of these subscribers attribute numbers of minutes of free time that do not correspond with any local subscription plans. For services such as call forwarding (40 claimed to have that) and voice mail (34 noted this service as a part of their subscription), we find distinct overlaps in service between pagers and cellular telephones. The self-reported number of cellular telephone calls made per week appear in Figure 14.

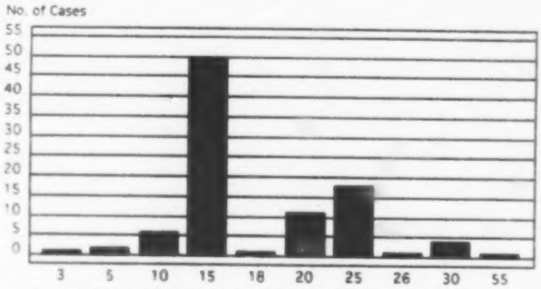


Figure 13. FREE AIR TIME REPORTED AS PART OF SUBSCRIPTION BY CELLULAR PHONE OWNERS (minutes)

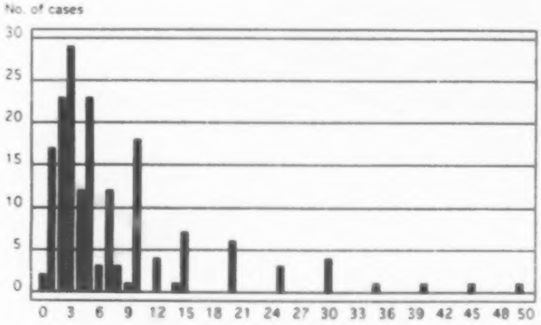


Figure 14. NUMBER OF CELLULAR TELEPHONE CALLS REPORTED MADE PER WEEK

Observed age and sex differences may be more a function of sociocultural stereotyping and social perceptions of personal needs than actual male/female or age differences. One supporting indication for this observation is that no significant differences between the sexes are evident in the self-reported use patterns. There seems to be only an external perception (not an overwhelming internal need as manifested in the self-reports) that women value safety significantly more than men. Another indication is that nonowners who filled use-pattern data based on their perceived - as opposed to actual - needs were skewed significantly more heavily (and therefore more stereotypically) toward believing the "safety" factor related to the ownership of cellular telephones.

8. SUMMARY & CONCLUSIONS

The 1990s have marked a dramatic and continuing trend toward personal uses of cellular telephones and pagers in addition to the professional use of these devices. Hawaii has also continued to show a strong market penetration rate for mobile telecommunication services that surpasses that of the Continental United States. Despite a marketing "push" based on a justifiable rationale to carry a cellular telephone for safety reasons, in the population sampled safety is not the most-cited reason for carrying such a device. As high as the need for safety and security may be, this is in fact superceded by the need to be "reachable" and to "always stay in touch." Although the power of these wireless devices combines two irresistible basic human needs - connectivity and control - we see other demographic and socioeconomic differences in the more subtle manifestations of these needs. The use of cellular telephone and pager cuts across every ethnic and racial background and every socioeconomic sector in our population (see Figures 15-17 at end of article). Yet, the stratification of use by ethnicity does not necessarily follow the income stratification observed in our economic sectors in Hawaii, which would have resulted in a predominantly Caucasian population's use of cellular telephones & pagers. In addition, there is some evidence for a cultural value system in Hawaii that cannot put a price on "connectivity."

This initial study on Oahu points in the direction of certain common human characteristics that span across a population with a diverse ethnic and socioeconomic background. Although the results may not be definitive, it may be possible to generalize some of the outcomes and pave the way for a broader understanding of the acceptance or "unacceptability" factors for mobile communication devices from a personal use perspective. The most critical issue is that the technology in and of itself will not change the way men and women idealize or stereotype each other. Some basic physical facts about human surroundings will continue to affect the way we respond to our daily environment. Older adults will generally be protective of children and younger adults. Whether women will continue to be lumped with children in terms of those same needs is a social matter that will not necessarily yield to new electronic solutions separate from its cultural base.

For many individuals, the personal use of such telecommunication devices began as a result of receiving a gift from a loved one and the economic realities of the ongoing expense has not yet set in. A very small segment of the respondents gave some thought to the question: ***Please explain how you justify the monthly cost of your service(s) if you are a cellular phone or pager user; e.g., what have you given up in order to be able to afford these services?*** A few saw the cost coming out of their entertainment budget, others said they worked more to earn the money, while the majority left the question blank or simply stated that they were not responsible for paying their own bills (those who received the devices as gifts and used them to satisfy another person's needs). What we are witnessing may be partially a result of a rotation of the population through the ownership cycle, rather than a consistent addition of new customers added to the existing base. Of course, the marketing trends in this industry also make a "gift" of the device in return for long-term subscription to the services. Whether such gift giving will continue to support the industry in the long run or whether the habit will be hard to break is as yet unknown. There is some indication, however, that once the reality of the large monthly bills for cellular telephones sets in the user response is not consistent: some will add a pager to cut down on the cellular expense, others tend to cancel their subscription, while many tend to modify their use patterns.

9. REFERENCES

Cellular Industry Report is a monthly publication available to the members of the Cellular Telecommunications Industry Association (CTIA) and is among the many industry publications that offers up to date market information.

Chapin, B. (1990) "After the quake," *Communications, 27* (5), pp. 30-36.

Davis, D. (1993a) "Social Impact of Cellular Telephone Usage in Hawaii," in: *Proceedings, PTC'93: Pacific Telecommunications Council Fifteenth Annual Conference*, January 17-20, 1993. Edited by James G. Savage and Dan J. Wedemeyer. Vol II, pp. 641-648.

Davis, D. (1993b) *Cellular Telephones in Hawaii: Benefits, Risks, and Future Prospects*. Report to the 1993 Hawaii State Legislature. Honolulu, January 1993.

Dordick, H. and R. Larose (1992). The telephone in daily life: A study of personal telephone use. (Made possible through a grant from the Bell Atlantic Corporation). Michigan State University.

Hsu, H. (1992) ***The uses of cellular telephony in Taiwan.*.** **Thesis, Michigan State University.**

Kwon, H. S. (1995) *User acceptance of cellular telephone technology.* Dissertation in progress, University of Hawaii at Manoa.

Tannenbaum, R. (1991) *Cellular telephones: A comparative analysis of their adoption and impacts.* Thesis, Carleton University, Canada.

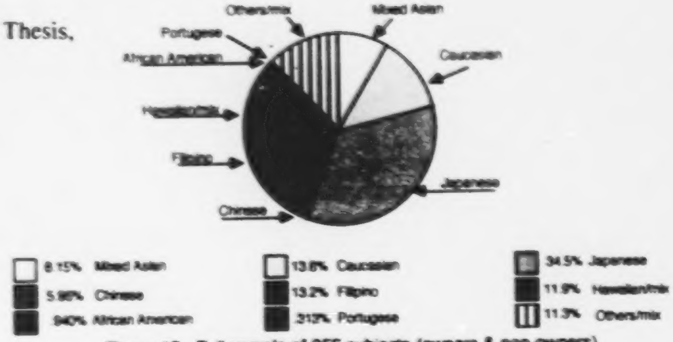


Figure 15. Full sample of 355 subjects (owners & non-owners) Distribution by ethnicity/race

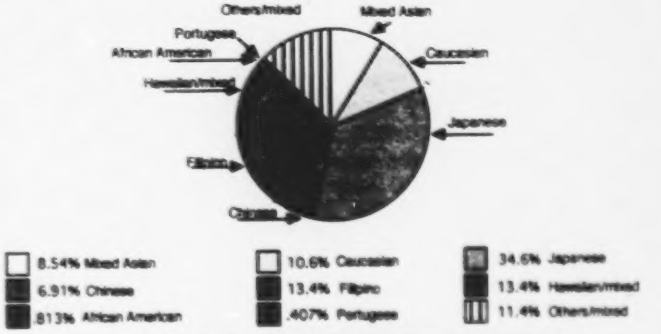


Figure 16. Distribution of cellular telephone and pager owners in the sample population by ethnicity/race

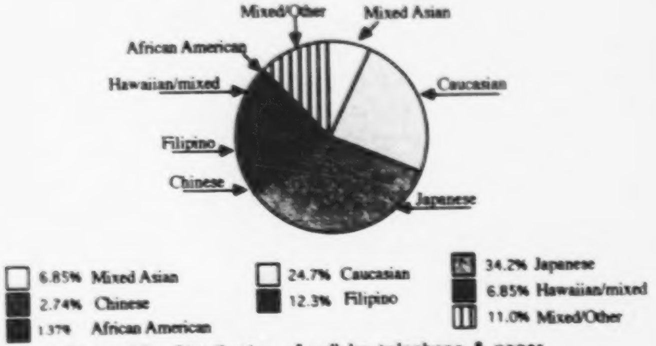


Figure 17. Distribution of cellular telephone & pager non-owners by ethnicity/race

A SECOND LOOK TO CTSC

Dario M. Goussal
GTR-UNNE
Resistencia, Argentina.

1.Abstract

This paper examines technological and environmental factors of CTSC planning in the next years regarding some experiences like the pilot trials successfully performed in Brazil since 1992.This include the review of key issues affecting regional plans envisaged for the Mercosur area and other countries, on the same way of the recommendatios approved by the ITU's 1 World Telecommunications Development Conference (WTDC-94).

2. Introduction

Since their early days in Sweden and Denmark in 1985, the impact of Community Teleservice Centers-CTSC-on rural development has been significatly increasing in many countries. Indeed, the CTSC approach became suitable for rural areas as soon as telematics equipement and services became cheaper and closer to developing zones. Rather than attempting to bring just plain telephone to groups of householders in rural areas, the Integrated Rural Development(IRD), a plan proposed by ITU-WTDC94 Final Draft should aim as well to provide access to telematics services for whole communities at strategic locations. In the cycle 1995-1999, this will be piloted by building CTSC in some 20 developing countries,priority being given to the LDCs. In the long term, the goal is to provide CTSCs for all rural communities needing such services and to achieve the critical mass required through regional IRD programmes. Such leading role confered to CTSCs within ITU/BDT 1994 Buenos Aires Action Plan led to undertake the study on issues regarding their future and their expected impact worldwide.Services and applications supposed to be available at a given rural CTSC(telecottage, distance learning, telediagnostics, business office, database access, teleconferencing and other facilities) should also be mutually compared in order to take measure of their respective impact in the developement of the area.

3. The CTSC concept since the WTDC-94 Buenos Aires Action Plan.

The CTSC concept began in the scandinavian countries around 1985 as a reaction to the lack of adequate teleservices in rural areas and to the continuously increasing demographic stream from rural to urban areas.Although the main purpose was not the same for different country plans,a kind of blend between public services and computer-based training facilities were found in every CTSC location. Along ten years of succesive trials worldwide,after suffering the rise and the fall of national and international promoting policies,their transit through many technological changes,service policies and funding alternatives has proven to be good enough to finally achieve an express recommendation of ITU World Telecommunications Developement Conference (WTDC-94) among the initiatives of the Buenos Aires Action Plan (1).

As stated there,the community telecentres are supposed to lead major roles within the initiatives of the IRD (Program for Integrated Rural Development) included in the Plan, wherein two goals were proposed:

a) In the long term: To provide telecentres, equipped to offer telematic services and support,and public phones for all rural communities in developing countries -and as required,in developed ones- serving approximately 10.000 inhabitants (Fig.1).
b) During the next cycle (1995-1999): By setting up CTSC Pilot Plans in some 20 countries in developing regions,priority given to the Least Developed Countries (LDCs).

ITU's Integrated Rural Development concept covers all human activities in the rural environment by concerting the development of all sectors such as agriculture,education, transport, health care and so forth. Its crucial importance has been recognized in many fora including the 1992 Rio Declaration on Environment and Development adopted by the UNCED. By providing telematic services concentrated in single service locations for whole rural communities it is possible to promote local entrepreneurship, to make viable teletraining, telework, telemedicine and to facilitate trade, banking, public administration and tourism with investments.Some ideas were discussed during the WTDC 94,such as (2):

- location of CTSC in post or telegraph offices cooperating with postal services and the Universal Postal Union (UPU).
- partnership of equipement suppliers like VSAT and low cost radio terminals, and even satellite or radiocommunications services providers in the CTSC pilot projects to be launched.
- the role of CTSC assotiations like CTSC International-and the need of joining the CTSC themselves in national or international organizations.
- networking of CTSCs -among themselves and with electronic networks in order to support a wider variety of services at lower costs.This task will be carried out together with Programme No.12 (Telematics).
- regional pilot project programmes to be undertaken in next years, in order to reach the critical mass required to bring about and to demonstrate the advantages of CTSC(intended to be very difficult to achieve through isolated country programs).

The Buenos Aires Action Plan working documents succesively submitted by ITU/ BDT to the conference (WTDC-94/DT/2, DT/2-Rev.1 and Rev.2) had included some IRD proposed activities as shown in Fig.2 (n1). According to that, NGOs should assist in training CTSC staff and participate in the evaluation of pilot projects and in the "marketing" of CTSC concept and services. Such activities were proposed in mid-1994 by GTR UNNE to the National Parliament of Argentina,in order to be carried out afterwards. Since no CTSC national plans were been envisaged at the time,a R&D program was then set up at UNNE in order to examine the model and viability of such a project and then the best way to integrate it into regional plans as addressed within the WTDC-94 IRD Program.

4. A Brazilian Reference Model (1993-1995)

The brazilian telephone state-owned holding, Telebrás began studying on the CTSC approach in 1991 by means of its RE-D471 Resolution (20) which assessed the implementation of one telecentre in each state of the country with testing purposes. The pilot project involved three phases:

I) Comprising the conception of the global project; elaboration of the Tuition Module project; installation of 3 pilot CTSC located in Brusque (state of Santa Catarina), Toledo (Paraná) and Mossoró (Rio Grande do Norte); conception of planning,implementation and evaluation tools for the pilot units;and training the future coordinators (completed late 1993).

II) Comprising the installation of rural telecentres and the remaining pilot units in every state of Brazil; enlargement at 4 regional-based companies, until the completion of 44 telecentres in the country; integration with national main projects for education (Televias), science and technology (Tecnopolis),extension of the plan to the brought of national and foreign partnerships; and definition of the networking structure.

III) Comprising the extensive implementation of CTSC in some 2 of each 3 municipal regions, with a goal of some 3.000 CTSC by the year 2004.

Even though the brazilian pilot plan looks quite ambitious regarding its proposed goal for y.2004-the plan was finally running much slower than forecasted-its value as a first, unique experience in Latin America seems as strongly related to the future of CTSC in the MERCOSUR countries (Brazil, Argentina,Uruguay and Paraguay with others as candidates). In april 1992 Telebrás submitted a paper to the American Regional Telecommunications Conference held in Acapulco,Mexico(3). As a result the Conference gave the approval to a Resolution Project recommending the introduction of CTSC in both rural and low income areas. Brazilian telecentres comprise services and facilities organized in four modules:

1) Public Services and Teleinformation: post, bank, water, telcos and power companies,federal and municipal taxes boxes and other public or private entities sharing common datalinks to their main head offices.
2)Teleoffice or Teledesk: Center for free-lance professionals, small enterprises and local entities which need temporary office services such as fax,e-mail,personal computers,printers,phones and photocopy devices.
3) Business Applications: Supporting services aiming to develop the economy and to improve productivity in rural and (small) urban communities: advice on agriculture and livestock markets, cooperatives, accounting, legal issues, taxation and product diffusion through remote access to databases and technology-based advising.
4)Tuition Applications: Educational environment for computing and multimedia formation,aiming to help children and adults by training teachers or small enterprises'personnel on "teleinformatics literacy".
The project, even when inspired in the nordic telecentres,has differences:

a) **Ownership:** the model is a kind of multilateral assotiation with government support.Telebrás holds the link to the network, but the services are provided by either public or private entities as partners (parceiros).
b) **Location:** located in mid-size villages -50.000 to 100.000 inhabitants- while the ITU-IRD suggested smaller communities (from 10.000 ones).
c) **Size:**As a result,both the building area -400/500m2- and the average rate of use -just 8,937 attendings a month for the Toledo CTSC from a 25 month average (october/1993 to october/ 1995)- (4) are higher than the european CTSCs.The last sample accounted for this report(October/1995) gave 13,775 attendings distributed among the Teleoffice module (5,028), the Public Services (6,669) and the Tuition Module (2,078) (Fig.3)

The Telebrás pilot project started with mid-size, high-potential villages in outstanding regions of the country on a community-commitment basis. Brazil had over 78% of urban households and 46% of business sites without just a telephone line;in the Toledo area in 1993 there was 6,232 lines for 86,220 inhabitants (7,23 %) even when being this community an important industrial node of the west of Parana state, near the Paraguay and Argentina borders (5).Data and value-added services were rare or limited; Internet access and remote/multimedia capabilities remained practically unknown.The role of local entities such as the municipal government, commercial and industrial assotiations and the community representative forces was crucial for establishing and operating the services on a partnership basis: provision or leasing of buildings, negotiation with service and equipement suppliers,sharing of common expenses and staff policies had to be included within each CTSCagreement.Apart from the 3 urban CTSC, the first rural telecentre of Brazil started operating in 1994 in Vila Nova in the state of Paraná,only 8 months after Toledo with a local household assotiation as its main partner.It was also foreseen the establishment of new rural telecentres in Novo Sarandi,Dez de Maio and also a suburban one in Vila Pioneiro -the last one aiming to bring telemedicine services-, all them near the Toledo municipal area.

5. The Four Barriers in 1996 and Beyond.

According to Lars Qvortrup`s seminal report (6) there are four main barriers to overcome in order to sharing access to teleservices in rural and low-income areas:
1.-The network: In many regions the lack or the obsolescence of transmission and switching media preclude even the access to plain telephony. How to start there bringing data and advanced services requiring digital connection to the public network? The answer seems to be related to technology through two parallel trends:

a) **Broadening the pipes:** B-ISDN, SDH, SONET, Fast Ethernet, FTTC, FDDI and ATM platforms will broaden the transport capacity thereby allowing cheaper medium and long distance high speed datalinks.
b) **Compressing the data:** CELP vocoders, cellular data packet (CDPD), digital video compression,Asymmetrical Digital Suscriber Line-ADSL and other technologies aim to reduce the data bit rate required for telematic services. In particular,ADSL would be highly suitable for telemedicine teletraining and distance education performed by CTSC located in suburban areas.According to Stewart,new ADSL terminals are able to achieve some 5.6Km over 0.5 mm (24 AWG) telephone

wire carrying a 2,048 Kbit/s. data stream (E-1)or a 1,540 Kbit/s one (T1) (7) Thus,T-1 or E-1 medium rate datalinks suitable for suburban CTSC services would be feasible by using existing suscriber copper pairs.

2.-The services: Even upon the existence of appropriate links to PSTN and PSPDN national networks,the availability of teleservices suitable for rural and low-income communities seems not as good. In most cases,it is suspected the choice of services to be given to such communities depends on the demands of nearest urban areas rather than on their own needs.

3.-The cost: Rural entrepreneurs and small enterprises often cannot afford on their own the equipement and software costs, including their continuous upgrading and maintenance.

4.-The qualification of the user:To the same extent computer-based work require skilled users-and thus comprehensive training,people living in small communities often remain afraid and sceptical about them.

From a general point of view the CTSC concept tries to overcome these barriers by concentrating adequate information services, training ressources and their related equipement into a single location thereby allowing low end-user costs. Nevertheless,after ten years of pilot plans and experiences worldwide it is widely recognized that such barriers are not going to be surpassed per se. Adequate technology,financial options and developing policies had to be found for more than 200 telecentres today in operation in the world, and many others have to be envisaged to accomplish the ITU's IRD programme in next years, having noticed on the priority given to LDCs(21). In such a way the CTSC concept became adult since the WTDC-94 Buenos Aires Action Plan: many countries including some LDCs relies on them as a promising way to improve the quality of life of rural and low-income communities. Structural reforms and new technologies tend to modify the framework of proposed regional pilot plans: in Brazil,for instance the National Parliament approved in june, 1995 a reform which enabled private investments and the virtual end of the Telebrás monopoly.Other countries are also making structural reforms while expanding and enhancing the networks with modern technologies.It is mandatory to examine the impact of such changes and related issues, as a second look to CTSC for 1996 and beyond as follows.

6. Targeting Regional Plans.

Every proposed telecentre has a main target to be carefully identified. It depends on the main needs of the community in the present and also in the next 5-10 years.Of course, a rural or low-income location could have huge unsatisfied demands.Among those related to information and telematic services,it is possible to select a set of dynammic priorities- given that they could differ in the long run-.The privatization of nearly 100 government-owned industries in Western Europe until 1998 will likely lead to shed about 750,000 jobs,according private forecasts recorded by Coll(8).The EC Telework-Telematics Forum (ECTF) document WTDC-94/19-E (9) and the so called Delors White Paper pointed out 4 priority applications to the proposed europeam high-speed network: teleworking, teletraining,telemedicine and links between administrations.On account of the high overall unemployment rates(17 million in1994,around 11% of the EC workforce)the relative weight of the 10million of microenterprises -employing under 10 persons- gathering 70% of turnover and employing 70% of Europe workforce; and the relatively well-distributed education and health care ressources in the EC countries,perhaps a priority for the EC information highway will be teleworking applications.In Latin America,among the four countries of the Mercosur area, economic reforms impacted in almost all socioeconomic indicators(See F.4).According to latest World Bank data, in 1994 income per capita accounted from USD 1,510of Paraguay up to USD 7,220 of Argentina but unemployment rates were only 2.1% for Paraguay up to 12.5% of Argentina (skyrocketing up to 18.6% last may/1995 -the second highest in the world). Country indicators like literacy rate, rural population evolution and sectoral GDP could also be arranged as a matrix for macro-level comparison purposes To some extent we could figure out from such matrix the "big shape" of the initial target of national CTSC pilot plans:powerful as telecottages for Argentina and Uruguay,perhaps closer to distance education,teletraining or telemedicine for Brazil and rural-style for Paraguay.Targets may change with different development stages of the pilot area. A services menu has to be designed for the model,with services brought on a public basis to best cover the target while optimizing the overall efficiency.Countries like Brazil and Argentina whose long distances and low population density make matters worse need rugged,reliable equipement. A slim, well-trained staff of qualified persons to operate the CTSC has proven to be vital for success in both teaching and managing responsibilities.

7. Usage Tariffs.

The ITU/UNESCO report:"The right to communicate: at what price?" (10) summarized the analysis and recommendations of a meeting of experts in tariff policies and costs held in Geneva in 1993.Among them, the recommendation 6.4.1. stated: "UNESCO and ITU/BDT should,in cooperation with telecommunications operators and users,respond to the needs of Member States for the establishment of common networks and services in the fields of education,science,culture,communication,mass media and information,to maximize their impact and benefit from lower costs.Projects of interest might possibly include teleports serving major concentrations of users and telecentres offering community access".In this way, governments are encouraged to work with ITU and UNESCO on a step-by-step tariff reform to promote the establishment of such networks;users,to ask the carriers for tariffs based on incremental costs; PTT administrations,working with ITU are encouraged even to consider subsidies for short time with the aim of creating infraestructure to support some sectors of public concern(Rec.6.3.1 to 6.3.4., WTDC-94/4E). Usage tariffs are critical for telecentres Services like distance education, teleconferencing, telemedicine, telediagnostics and even many popular Internet facilities (e.g.FTP, WWW and Gopher) need apropriate usage tariffs to create the critical mass among users of rural and low-income communities.Nevertheless, national PTTs are often reluctant to specific subsidies as proposed by UNESCO, and incremental costs tariff policies may be not as good everywhere. Incremental costs-based tariffs depends on the"network topological memory"concept as described in other papers (11,12) and on the"sequence of network development"previously pursued as accurately remarked by Melody(13).Whether a new rural user have or not to pay an excess in the intended marginal service costs due to a given wrong expansion historic pattern pursued by the network in the past,is not as relevant as the price of the services on its own.Lower prices mean greater usage of existing services but also new users to them and the adding of new services that might not become viable otherwise. At the macrolevel,the relationship between the tariffs and GDP per capita,or the price of local calls could be useful for comparison (Fig 4).

In Argentina, a 2-minute national long distance call (840 Km up) costs approximately 96 times more than a local one.Even greater imbalances could be found respect to the international traffic. Given the historic pattern of traffic flows inside the country towards the main cities and mostly to the nation's capital this led to implicit tariff subsidies from rural to urban areas. Rebalancing such tariff schema has proven to be hard to accomplish even when the regulatory body (CNT) agreed and encouraged it. Indeed, for a particular service to be brought to CTSC customers,usage tariffs should be thought as good not only for the CTSC and the service provider, but also for the customer's business. Moreover, a better usage tariff would be good also for his/her next (new) business.

8. Rural Structural Poverty in Latin America.

A demographic study for Latin America from CELADE (1991) (14) showed that children from 0 to 9 years old would decrease 6.5% between the years 1990-2000.Young population (10-19 and 20-29 y) is going to decrease 3.4% and 0.7% respectively.A survey from CEPAL (1993) on the structural poverty and indigence in Latin America(15) indicates for 1990 some 30% of latin american (rural) and 13% (urban) householders below the indigence threshold while 53% (rural) and 34%(urban) householders below the poverty threshold.As concludes from such surveys Dirven (16) the way to enhance the quality of life of rural population-by means of family income improvement-is the job productivity enhancement, even out of the mere agriculture jobs.Actually above 30% of rural population in Latin America is working out of the agriculture/ livestock sector. Moreover,empirical studies e.g. Cotlear (1989); Lockheed, Jamison and Lau (1980),Figueroa (1986) and Phillips (1987) referred the importance of formal education to the ability and the willingness of individuals living in rural settlements to the adoption of new technologies to specific requirements of their farms and to take advantage of them. Basic math operations and calculus among other elementary skills were browsed by Figueroa (17) as critical for the right use of farm ressources (seed, fuel, harvest yields,animal production and management,etc.). By using rural productivity measurements by FAO and the World Bank for the whole Latin America,Argentina and Brazil,Dirven's estimation for small rural enterprises net aggregated income shows a clear gap between the mean value for such income and the possibility of purchasing and maintaining on their own modern information and technology-based equipement(F5).

9. Job Promotion and Rural Job Viability.

Job promotion in rural areas by using teleworking facilities relies also on viable tariff levels and efficient training as the main variables.Telework and telecommuting will increase in next years not only in developed countries,as pointed out by Jack Nilles in the European Union (18). As a surprising paradox, the worst concerns for many developped countries could be at the same time the best expectancy of change for developing region's rural inhabitants:CTSCs could be the new tools for rural workforce transformation and improvement.It depends on how soon information and networking technologies enable companies to reach reliable, well-prepared teleworkers in telecentres located far away their urban headquarters by taking advantage of low cost transmission media like B-ISDN,SONET or ATM platforms.Nevertheless,the problem of rural job promotion is still far from such forecasted possibilities.The qualification barrier,as said Qvortrup is here the main wall and looks hard to overcome.Usage tariffs on their own are still too high to make viable the approach,and the few CTSCs today existing in developing countries and linked to networks by low speed datalinks will unlikely be mature to perform teleworking missions before several years.A more realistic point of view would show 3 levels of possibilities in the teleworking approach:

1) **Local job enhancement**: Aiming just to cover the needs of trained people to be hired by companies already existent in the same area or in near urban nodes,with facilities suitable for self-managed entrepreneurs.
2) **National telematics node**: The CTSC aims to create permanent new jobs by carrying into the local community information and telematics-based work from companies outside the CTSC area. Examples are telemarketing and market-survey companies, credit card validation centers, air tickets and tourism agencies.(22)
3) **Regional or international nodes**: The CTSC aims to create highly productive new jobs by carrying into the local community telematics-based work from companies abroad. Such jobs usually require well-prepared teleworkers with ability in other languages, very reliable datalinks and security software, and takes advantage of discount tariffs in foreign countries based in time differences.

These levels comprise increasing difficulties in every sense. The first one is already accomplished by many CTSCs worldwide, as its goal is just to hinder outside area workers to have to move to the community for making local information-based tasks.The second one is likely better known through the popular tele and tecnomarketing companies. As an example,a good traditional salesperson in Argentina could make some 200 contacts a-month with about $ 8 average cost per visit. A telemarketer is supposed to make above 1,000 contacts a month with about $ 1 average cost per contact,depending on usage phone tariffs(n2).Advanced services such as audiotext,interactive voice responsing (IVR), automatic dialers and speech synthesis devices,besides affordable tariffs would allow such services to be run from a quiet rural telecentre instead of from noisy and busy telephone lines of the company's headquarters intown. There is some warning from Jack Nilles about the last level: international salary and work-regime gaps would result into ethic concerns except in the case of transparent, bilateral agreements.

10. The Community Profile.

The last boundary -or perhaps the first one- on the CTSC proposed new international role is just the core of them: the services are going to be used on a common way, on a public access basis.To a certain extent, less privacy,less comfort,less opening hours,less "intimity" in the typical customer daily work. Just the establishing and running of the telecentre requires communities with high "communitary sprit" thereby precluding CTSC installation everywhere. It was browsed in different locations such a community profile by regarding historic backgrounds and behavior in the past. Communitary experiences like road maintenance consortia, rural cooperatives, volontary firefighter corps,etc. could reveal by looking to their results whether the community has or not such sprit.As CTSC requires to share many things among the community (building, common equipement and expenditures, staff, development plans, etc.) a general mature attitude to privilege the community is mandatory. Transparent policies should be agreed ensuring to give priority to the community welfare.The population size and the socioeconomic aspects influence the community profile and modifies the foreseeable impact.

Too large villages,wherein a lot of computers,printers,modem-faxes and application sofware have been sold to private households already do not seem as suitable for a pilot area CTSC since the impact would be null.On the other hand,very small ones could hardly achieve the lowest traffic threshold to make it viable.However,the start-up budget may be very modest.Well-organized rural telecentres e.g Vila Nova in Brazil(26), or Ainsworth in Nebraska (USA-pop.1,870) -the last one of which began operating just with 2 computers(1 borrowed),as a case study reported by Campbell(25)-could survive below the 10,000 IRD suggested target due to collaboration rather than budget.Otherwise,a mid size community of self-entrepreneurs, students and small entererprises holding a strong communitary profile is likely the best choice and will have more chances to success.As a result,the CTSC concept must be thought as stated in the Buenos Aires Action Plan IRD program:a key part of a truly,sustainable rural development process for the next years worldwide. +

Acknowledgement

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Notes

(1): These activities were included in WTDC-94/DT/2-Rev.1 y 2 but not in the Final Draft.

(2) Based in estimations of early 1995 in the Buenos Aires metropolitan areas. See e.g. Collis, Daniel: "Tecnomarketing al Rojo Vivo". Rev. Apertura. Buenos Aires, 4/1995.

References

1. ITU-BDT: I World Development Telecommunications Conference. Final Report, Buenos Aires, 3/1994
2. ITU-BDT: ibid.Documents WTDC-94/DT/2,DT/2-Rev.1 y DT/2Rev.2.
3. Fischer, Helena and Mello da Silva, J:"Community Teleservice Center - CTSC Project in the Telebrás System"- Rev.Telebrás 16(55) 9/1992.
4. Telecentro Comunitário do Toledo: Estadística do Atendimento Mensal.- Toledo, PR. Brazil, 5/1995 y 11/95.
5. Prefeitura Municipal de Toledo- Fundacão Toledo: "Caracterizacão do Município". Toledo, PR. Brazil 1994
6. Qvortrup, Lars:"Community Teleservice Centers: a mean to social, cultural and economic development of rural communities and low-income settlements. Impact of CTSC".Odense University-CTSC International. I World Telecommunications Development Conference. Buenos Aires, 3/1994. Document WTDC-94/7-E.
7. Stewart, Alan: "PTTs play video on demand: ADSL"Telecom Asia, No 8.Hong Kong, 11/1994.
8. Coll, Steve: "Retooling Europe". AT&T-In Depth, USA 10/1994.
9. The European Community Telework/Telematics Forum (ECTF): "Towards a common agenda on telematics and teleworking". I World Telecommunication Development Conference. Document WTDC-94/19-E. Buenos Aires,3/1994
10. ITU/UNESCO:" The right to communicate: at what price? " I World Telecommunications Development Conference. Buenos Aires,1994. Document WTDC-94/4-E.
11. Goussal, Darío M.:" Unrestricted Counterline Expansion in Large Rural Systems". 6th. ITS European Regional Meeting. Khania, Crete (Greece). 9/1994.
12. Goussal, Darío M.:" Local Loop Reconfiguration and Rural Service Availability"- Proc.17th. Annual PacificTelecommunications Conference (PTC-95). Honolulu, USA, 1/1995.
13. Melody,William H.:"The Overlooked Opportunity: Rural and Remote - Area Telecoms"Pacific Telecommunications Review. Vol.15 No.2 - - USA ,12/1993.
14. CELADE (Latin American Demography Center): Boletin Demográfico Año XXIV, No.47. Santiago de Chile, 1991.
15. CEPAL (Economic Commision for Latin" America and the Caribe): Anuario Estadístico de América Latina y el Caribe-Edición 1992". Publication of UNO. Santiago de Chile, 1993.
16. Dirven, Martine:"Expectativas de la Juventud y el Desarrollo Rural" Revista de la CEPAL 55.Publication of UN.Santiago de Chile,4/1995.
17. Figueroa,A.:"Productividad y Educacion en la agricultura campesina en America Latina ECIEL-BID.Programa deEstudios Conjuntos. Rio de Janeiro, 1986.
18. Nilles, Jack:"Teletrabajo en la U.E."Revista CP. No.1 Buenos Aires, 9-10/1994.
19. Acevedo,Mónica G. and Gomez,NancyE.:"Proyecto Piloto de Telecentros Comunitarios Rurales" GTR-UNNE. Conference held at INFOCOM -95. Buenos Aires, May 8th.1995.
20. Telebrás-Departamento de Gestão Mercadológica:"Telecentro: Services and support for telecommunications and informatics". Brasilia, Brazil.1994
21. ITU - BDT: " Situation of Telecommunications in the LDCs" - I World Development Telecommunications Conference. Buenos Aires, 3/1994. Document WTDC-94/DT/14-. E.
22. Mc Phail,Thomas L:"Issues and Opportunities for Telecoms in Rural Areas ".University of Missouri - St.Louis.Telecommunications of the Government of Alberta,Canada.Pacific Telecommunications Review, Vol.14-No.4. 6/1993.
23. Saunders, R. Warford, J. and Wellenius, B.: "Telecommunications and Development" 2nd. Edition.The World Bank. USA, 1994.
24. ITU - BDT: "World Telecommunications Development Report". I World Development Telecommunications Conference. Document 2-E. Geneve, 3/1994.
25. Campbell, Christopher J.:"Community Technology Centers: Exploring a Tool for Rural Community Development" .The Center for Rural Massachusetts(CRM).University of Massachusetts,Amherst.July,1995
26. Báez, Lilia M.:"Proyecto piloto TCR" Conference at II International Rural Telecommunications Panel. Resistencia,Argentina.Sept./1995.

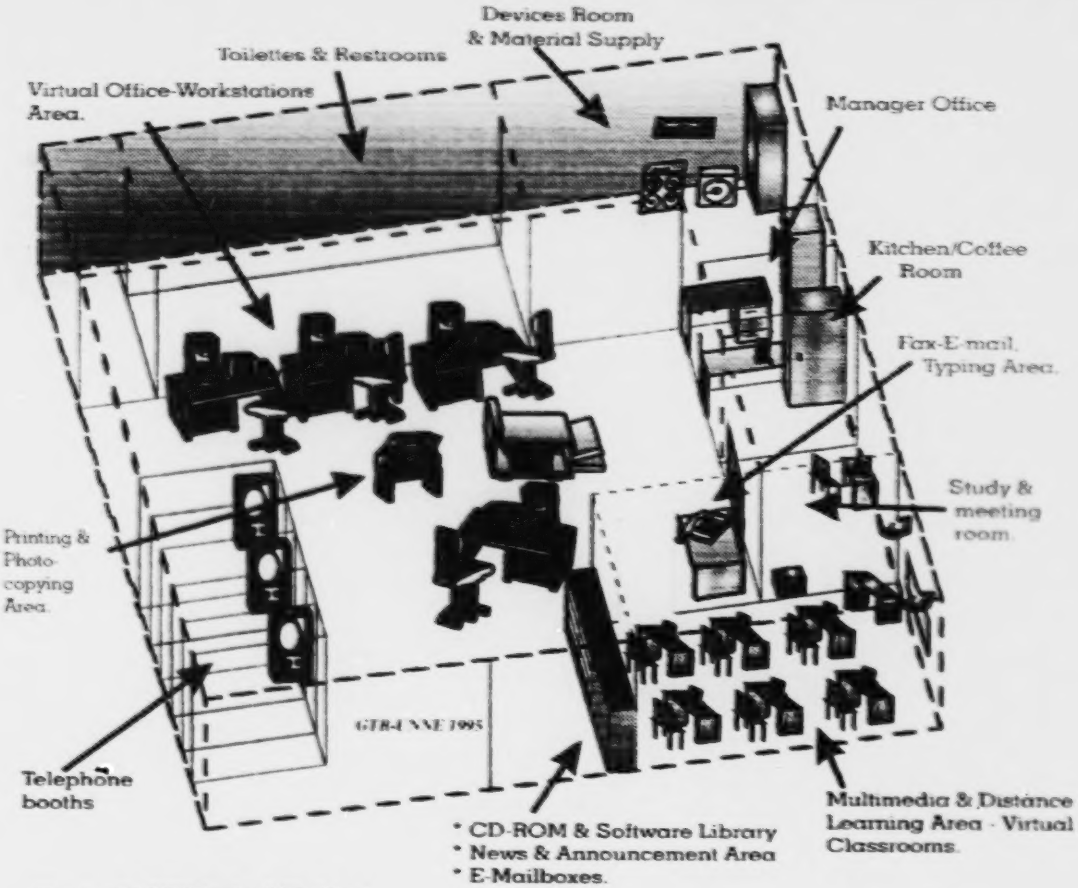

Devices Room
& Material Supply
Toilettes & Restrooms
Virtual Office-Workstations
Area.
Manager Office
Kitchen/Coffee
Room
Fax-E-mail,
Typing Area.
Study &
meeting
room.
Printing &
Photo-
copying
Area.
GTR-UNNE 1995
Telephone
booths
* CD-ROM & Software Library
* News & Announcement Area
* E-Mailboxes.
Multimedia & Distance
Learning Area - Virtual
Classrooms.

Fig. 1: CTSC-Typical Outline.

Fig . 2 **Activities for the Programme for Integrated Rural Development**

Programme Nro. 4 ITU, WTDC-94/DT/2 (Rev. 1) -E Buenos Aires ,21-29 March,1994.

Action	Governments	Internatinal organizations	Regional telecom organizations	BDT	Private sector	Other development partners
4.7. Training of CTSC staff 1	Participate (multiply training at national level)	Some UN agencies may assist	Assist	Coordinates	Sponsor training courses and offer fellowships	Relevant NGOs assist
4.8. Evaluation of pilot project	Participate	Participate	Assist	Coordinates (executes)		Relevant NGOs participate
4.9. " Marketing" of CTSC concept and services	Responsible at national level	Assist	Assist	Coordinate		Relevant NGOs participate

1. In cooperation with Programme Nro. 7 (Telematics) .As the CTSD obtains equipment for distance learning and TBT,and after initiation in use of multimedia ,the continuous training of CTSC staff will increasiling be carried out through distance learning and electronic networking.
2. NGOs: Non Government Organizations

672

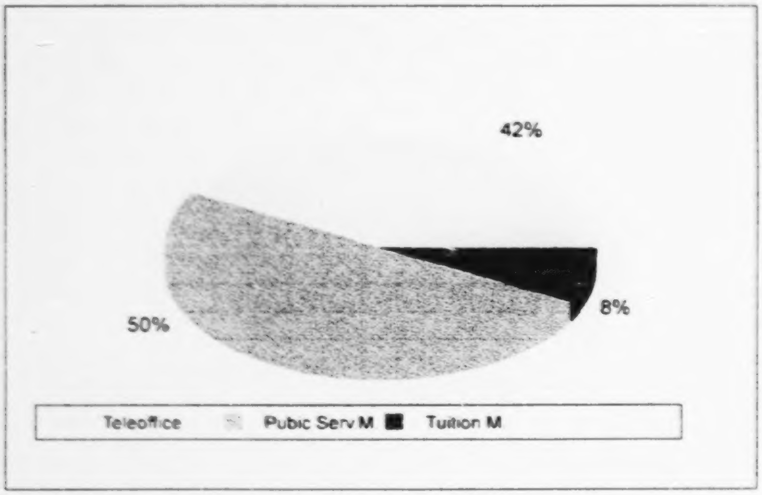
Fig. 3: Monthly Attendings - Community Telecentro of Toledo (State of Paraná, Brazil)

Month	Teleoffice Module	Public Services Module (1)	Tuition Module (2)	Total
From 10/93 to 10/94	13697	76889	1375	91961
11/94	1551	5791	415	7757
12/94	1950	5573	106	7629
1/95	3607	5761	324	9692
2/95	4873	4709	344	9926
3/95	5058	4694	502	10254
4/95	5356	4109	586	10051
5/95	5468	5874	946	12288
6/95	5646	5672	753	12071
7/95	6991	6026	1542	14559
8/95	5792	5565	1164	12521
9/95	3759	5921	1273	10953
10/95	5028	6669	2078	13775
TOTAL	68776	143253	11408	223437
Relative Share %(T)	31	64	5	100
Last year %	42	50	8	100

(1) Includes attendings by bank , water supply company ; telecommunications company and Prefeitura do Toledo (Municipal Agency)

(2) Tuition module started operating just in august,1994.

Source: Community Telecentre of Toledo Nov,1995.



Last 1-year pattern 131,476 Attendings

Fig.4: Mercosur Area Countries Comparison

Demographical Indicators		Argentina	Brazil	Uruguay	Paraguay
Pop. Density (inh/km2 -1993)		12.1	18.5	17.7	11.4
Rural Population	A-Relative Share % (1993)	12.9	21.8	14.0	50.6
	B-Mean year growth %(1990/93p)	-0.9	-2.2	-0.7	+1.5
Urban Population-Mean y. growth %(1990/93p)		+1.5	+2.8	+0.8	+4.2
Life Expentancy - Years, 1992		71.4	66.2	73.7	67.2
GDP-Total-in USDm/1993		255,595	444,205	13,144	6,825
Agriculture sector share (1993-%)		6	11	9	26
Industrial sector share (1993-%)		31	37	27	21
Services sector share (1993-%)		63	52	64	53
Income per Capita 1994 - in USD of 1993 -		7,220	2,930	3,830	1,510
Unemployment rate -%,1994		12.5*	4.5	10.4	2.1
Literacy Rate % 1990		95.3	81.1	96.2	90.1
Local call pulse-USD-1991(Nov,1995 w/taxes)		0.04 (0.051)	0.02(0.031)	0.04	0.06
Residential suscription as a % of GDPpc1991(**)		2.43(1.47)	0.39(0.26)	2.05	3.6

(*): Latest official survey released by INDEC (Argentina) in june,1995 indicated 18.6%

(**) Nov/1995 values for areas with>=10,000 main lines,taxes included.Parity R/USD=0.96

Sources: BID-Interamerican Development Bank World Report 1994;The World Bank,.World Development Report 1995; ITU-BDT(24).GTR-UNNE Rural Database,1995(**)

Fig.5: Latin America and Caribbean countries (1990)
Productivity and Estimated annual average income for small rural enterprises

	Productivity Measurement				Income estimation for small rural enterprises (1990)	
	Total Agricultural Sector Aggregated value USD m	Agricultural Sector - EAP (Economically Active Pop- thousands)	Aggregated value/ Agricultural EAP (USD / person)	Aggregated value per hectare USD	Small rural enterprise - Average area (hectare)	Mean aggregated value per small rural enterprise (USD)
Whole Latin American and Caribbean countries	104,716	41,238	2,540	690	2.1	1,449
Argentina	12,405	1,197	10,360	460	8.9	4,094
Brazil	42,288	13,366	3,160	700	2.1	1,470

Source: The World Bank, 1992; FAO , 1992 and Dirven, Martine: (Rev. CEPAL 55, 4/1995) (16)

CHINA'S EMERGING TELECOMMUNICATIONS INFRASTRUCTURE: MARKET ANALYSIS AND SOCIAL IMPACT

Jerry L. Salvaggio, Ph.D.
Salvaggio Research Associates

ABSTRACT

This paper provides an overview of the size and scope of China's telecommunications market and examines the potential impact of the modernization of China's telecommunications infrastructure.

China's telecommunications equipment market is now the largest in the world. Telephone switching capacity, as an example, is being installed at a rate equivalent to adding one regional Bell operating company (RBOC) to its national network every year. The country is expected to invest close to $10 billion every year for the next five to ten years on telecommunications equipment including cellular, transmission, microwave, satellite and central switching.(1)

INFRASTRUCTURE

Prior to 1980, China's telecommunications infrastructure was decades behind other Asian nations even for a Third World country. In 1979, China had a total capacity of 5.74 million telephone lines based on electro-mechanical equipment. Long-distance service was primarily manual and the telephone penetration rate was less than .40 percent.

In 1995, 13 million lines were installed throughout China bringing the total to 63 million lines. However, there is still a 6 month to 2 year waiting list for phone service depending on one's status and the city but the teledensity of the country is closer to 4 percent nationwide and much higher in large cities, such as Beijing. (2) It is estimated that 18 to 20 percent of Beijing's homes have a telephone. By the end of 1995, there will be close to 4 million telephone lines in Beijing alone.

Traditional Common Carriers

Telephone and data communications service has traditionally been provided by the Ministry of Posts and Telecommunications (MPT). Local telephone service is handled by the Posts and Telecom Administrations (PTAs) while long-distance service is provided by the Directorate General of Telecommunications (DGT).

Underneath the 31 provincial PTAs are 336 prefectural offices of the local Posts and Telecommunications (P&Ts), 2,000 plus branch P&T offices and almost 54,000 county and township P&T offices. PTAs are responsible for collecting revenue for telecommunications services and providing the MPT with its share.

In 1995, the State Council decided to begin the process of separating operations and policy. The first step was to spin-off the DGT as a separate company for long distance. The DGT now handles long-distance voice and data communications. The DGT's Data Communications Bureau operates China's Digital Data Network (DDN) and maintains Chinapac, the country's older, analog data communications network. The Mobile Communications Bureau is responsible for national cellular networks including the interfacing of intra-provincial cellular networks with the DGT's long-distance network.

The DGT is now theoretically separate from the MPT with its own business plan and its own president. How independent the DGT is from the MPT is debatable as its autonomy is still evolving. Strategic planning is coordinated and approved by the MPT. The ministry also continues to decide on major technologies to be employed in China. The MPT does not want this relationship to change as the DGT is a major source of revenue for the ministry.

New Common Carriers

In 1994, China's State Council approved two new common carriers (NCCs) to compete against the DGT and the PTAs. The NCCs are backed by a large number of firms and government ministries including the Ministry of Electronics and Industry (MEI). The MEI is a powerful ministry with more telecommunications factories than the MPT. The

MEI will increasingly be involved in China's voice and data networks.

The MPT's monopoly on common carrier service ended with the establishment of LianTong and Ji Tong. LianTong is known in English as the China United Telecommunications Corp., but is commonly referred to as Unicom. The NCC is spearheaded by the MEI and fifteen other organizations.

Unicom existed for several years in an unofficial capacity and typically had an adversarial relationship to the MPT and its local offices. Unicom's backers include the MEI, the Ministry of Power (MOP), the Ministry of Railways (MOR) and the China International Trust and Investment Corp. (CITIC). (3) Approximately 16 private firms hold equity positions in Unicom. Unicom is led by Zhao Weichen, president of the firm.

Unicom does not have to start from scratch. The MOR, the Ministry of Energy (MOE) and the People's Liberation Army (PLA) all have large, private networks. These existing networks include long-distance fiber-optic lines, microwave and very small aperture technology (VSAT). It is estimated that all lines combined come to 5 million. Prior to 1994 various ministries were permitted to own their voice and data networks, but were prohibited from leasing access lines.

Unicom's best hope is to convince the State Economic & Trade Commission to relax its rules on foreign ownership. This would allow Unicom to receive an infusion of cash from U.S. RBOCs and other international telcos. BellSouth, Nynex and GTE are well positioned in the Chinese telecommunications service market for this event.

Typically, Unicom provides licenses for subsidiaries to operate its networks. The local network operator must then interface with the MPT's local subscriber loop.

Unicom is not likely to find it easy to develop a comprehensive nationwide network and make profits in the short term. A number of problems must be solved before Unicom will capture more than a small share of China's telecommunications markets. The NCC is still under funded and is backed by ministries that do not always agree on a common strategy. Unicom must also interface with the MPT's networks.

Ji Tong Communications Co. Ltd. is owned by 30 state organizations and research institutes connected with the MEI and the CITIC. The NCC was established on September 28, 1993. The firm is led by He Feichang, previously a government official with the MEI.

Ji Tong is expected to provide cellular and data communications using private networks of 20 or more government ministries. Ji Tong will also offer value-added data services to industry and to academic institutions.

All of the above telecommunications carriers answer to China's State Policy Council (SPC) and Vice Premier Zou Jiahua. Disputes between the MPT and the NCCs are taken to the SPC. Throughout 1994 and 1995, the SPC tended to decide in favor of the NCCs on all important issues.

TELECOMMUNICATIONS POLICY MAKING

Telecommunications policy in China is the direct responsibility of the MPT. The MPT is a complex government organization with wide-ranging responsibilities for telecommunications and postal services. The ministry oversees common carrier service, supervises provincial telecommunications policies, conducts research and development, defines telecommunications policy, develops and promulgates telecommunications standards, sets tariffs and operates more than a hundred manufacturing plants. This makes the MPT somewhat analogous to combining in the U.S. AT&T, Bell Labs, the RBOCs, the Federal Communications Commission and the Post Office. The ministry had about 900,000 employees in 1995.

While the MPT continues to view the DGT and PTAs as part of its organization, it will increasingly be expected to promote competition.

Manufacturing Role

The MPT is a major manufacturing enterprise and a major importer of telecommunications equipment. Responsibility for equipment manufacturing falls to the Posts and Telecommunications Industry Corp. (PTIC), another MPT subsidiary. The PTIC is a collection of 28 factories which collectively account for 90 percent of the MPT's purchases.

Problems Facing the MPT

The MPT is beset with a number of serious problems which will affect its status as an important government ministry in the next five years. First, the ministry faces a devolution of power to other ministries that are intent on entering telecommunications. The MEI is responsible for electronics and computers, but is now backing two NCCs. The State Policy Council has made it clear that the MPT is to cooperate with the NCCs and assist them in connecting the networks of other ministries to its own. In essence, this is asking the MPT to assist its competition.

Second, the ministry is losing power to the provinces and three autonomous municipalities: Beijing, Shanghai and Tianjin. Each province and many municipalities have their own PTA and in many cases have a great deal of autonomy. Guangdong province, as an example, will invest upwards of $1 billion on telecommunications in 1995.

Each year the amount of direct financing the MPT provides to local provinces shrinks. In 1994, the MPT provided only 10 percent of each province's budget as opposed to more than 50 percent a decade ago. Large coastal regions are very well financed and most local provinces are able to raise cash from principal banks.

Third, the MPT continues to operate without the benefit of a modern telecommunications law spelling out its power. All recent attempts to pass such a law failed due to rivalry among ministries.

The MPT will increasingly become a policy making organization with little responsibility for operations.

TELECOMMUNICATIONS EQUIPMENT MARKET

Foreign firms sell millions of dollars of equipment to China. AT&T had 1994 sales of $60 million while Alcatel had sales of $600 million for the same year. Nokia is believed to have sold about $160 million worth of phone equipment in China in 1994. Perhaps the most successful firm is Motorola, which according to *Business China*, had 1994 sales of $2.5 billion in China. (4)

Most projections of China's telecommunications market rely on MPT figures which are based on projected revenues. These figures can be somewhat misleading for two reasons. First, the MPT is not the only importer of telecommunications equipment into China. The MEI is also a major importer. Second, only a percentage of the MPT's investment leaves the country. Some of it goes to domestic firms and a percentage of it goes to joint venture firms within China.

In 1994, the MPT invested close to $6 billion in China's telecommunications infrastructure. According to Wu Jichang, minister of the MPT, projected revenue for 1995, based on the first six months, will be about $9.4 billion. Most market forecasters use this figure as a basis for projections.

In 1994, China imported $4.34 billion worth of telecommunications equipment . This would represent about 70 percent of the approximately $6 billion the MPT purportedly invested in telecommunications in 1994. Japan accounted for 33.7 percent of this figure. Europe and the United States accounted for another 15 percent. The estimates presented here are based on import/export figures of the United Nations and the U.S. Department of Commerce.

The MPT generated about $9.4 billion in revenue in 1995. This figure might conservatively be raised to $10 billion if we add imports of the NCCs and other ministries. Using the ratio of spending to MPT investment reported in 1994 China will have imported about $7 billion in 1995.

Rather than using the 40 percent growth of the past few years as a basis for projecting market size we might consider three scenarios for the year 2000. At a conservative rate of increase of 10 percent per year (from $6 billion in 1994) China's investment in telecommunications equipment in the year 2000 would be $10.6 billion. At 25 percent, which is much more realistic, investment would come to $22.9. At 40 percent, investment would come to $45.2 billion. Historically, China's investment in economic reform has retrenched every few years. Therefore, the 25 percent scenario is the most likely.

It should also be noted that China might not continue turning over 60 percent of its investment to foreign firms. Both the MPT and the MEI are discouraging local provinces from giving more contracts to foreign firms where a domestic firm can do the job. The country's 1,000 telecommunications factories took in only 40 percent of the $9.4 billion spent in 1995. At a conservative rate of increase of 10 percent per year China's imports of telecommunications equipment in year 2000 would be $9.1 billion. At 25 percent imports would come to $17.2 billion.

Mobile telephones can now be found in almost all of China's provinces and in Beijing, Shanghai and Tianjin. The largest number of cellular subscribers are in China's coastal provinces and in Beijing

Cellular systems in use in China include Total Access Communications Systems (TACS), code division multiple access (CDMA), CT2 and Global Systems Mobile (GSM). Unicom is expected to be a major competitor to the MPT as a service provider. China's cellular market is destined to grow exponentially over the next ten years. There were about 1.6 million cellular phones in operation in China in 1994 and another 1.5 million added in 1995. This represents less than a 3 percent market-penetration level. Motorola and Ericsson are the two largest suppliers of mobile telephone systems. Motorola has approximately 50 - 60 percent of China's cellular market though the trend is toward more parity in the future. (5) A host of American and Japanese firms are building plants throughout China to produce new digital cellular phones. An increased number of state-affiliated firms are expected to compete with Motorola, Nokia and Ericsson for market share.

It is unlikely that China's current 200 percent growth of cellular will continue. However, even 50 percent growth would mean China will purchase more than ten million cellular phones between 1996 and 2000.

In 1994, China imported $885 million worth of switching equipment. Japan accounted for 46 percent of China's imports though Alcatel and Siemens have the largest share of China's central switching systems market.

Smaller firms such as Boston Technology, Compression Labs and Stratacom are selling voice and messaging systems, video conferencing technology and ATM switches.

The MPT plans to add about 12 million telephone lines a year through 2000. I project the addition of 15 million per year due to the growth of cellular and healthy competition from the NCCs. This would bring the total number of telephone lines to 138 million. This would result in a market demand of 75 million lines between 1996 and 2000.

China is currently in the process of upgrading all voice and data networks with fiber-optic cable. China's *Eight Five-Year Plan* (1991-1995) called for 22 major fiber-optic lines by the year 2000. As of mid-1995, 17 of the 22 fiber-optic cable systems were laid including a submarine cable to Japan.

The *Ninth Five-Year Plan* (1996-2000) calls for 17 additional national trunk lines including fiber-optic links between Qingdao and South Korea, Shanghai and Frankfurt, Germany and a network connecting Shanghai, Nanjing and Hangzhou. (6)

Major MPT Fiber-optic Route: Planned and/or Completed

SRA

China's telecommunications needs between 1996 and 2000 include cross-connect switches, fiber-optic cable, multiplexers, digital loop carriers (DLCs), voice and messaging systems and video conferencing equipment.

IMPACT OF MODERNIZATION

In addition to the above markets, China's computer market is estimated to be about $6 billion annually. The software market is about $600 million.

The development of a modern telecommunications infrastructure over the next ten years will have a positive impact on China. An extensive, efficient telecommunications system, based on competitive common carriers, will facilitate the development of China's economy.

Economic Stimulant

China is already the world's 9th largest trading country and is emerging as a major trading center in Asia. It will likely replace the United States as Asia's most significant trading partner. (7) A modern telecommunications infrastructure should serve as an economic stimulant over the next decade. Inter-regional trade is almost certain to continue to develop among China and its neighbors.

Telecommunications will also facilitate increased development of the natural economic triangles (NETS) that are developing along China's borders. (8)

Manufacturing Capabilities

China's economy will also benefit directly from the country's emergence as a major manufacturer of telecommunications equipment. The country will gradually assume an important role as a supplier of digital telecommunications equipment to other Asian nations. Between 1995 and 2000, hundreds of

Chinese factories currently producing analog equipment will be upgraded with the help of foreign firms. By the late 1990s, Chinese firms will be capable of exporting digital switching systems and other types of telecommunications equipment.

Currently MPT and MEI factories produce older fiber-optic cable for export. The revenue is then used to purchase synchronous digital hierarchy cable from foreign firms.

Foreign Investment

China will also benefit from continued investment by foreign telecommunications firms. Between 1995 and 2000 the MPT hopes to attract $50 billion in foreign investment. Multinational telecommunications equipment makers, such as Alcatel, AT&T, Ericsson, Fujitsu, Motorola, NEC, Nokia, Nortel, Siemens and others have reshuffled their global strategy and are investing millions to build facilities throughout China. Foreign investments that have been announced exceeds $2 billion. (9)

Open Communications Environment

China's first Internet network, ChinaNet, was opened in 1995. Sprint International routers are used to connect various research institutes with the National Science Foundation Network (NSFNET). The recent opening of Internet access to Chinese industry and academics is a positive move. Chinese research institutions will benefit from having open communications and the ability to share scientific data with other international research institutes.

Decentralization

The development of a modern telecommunications infrastructure may also have some negative effects. The development of telecommunications is leading to decentralization of central control.(10) Government bureaucrats relinquished central control for a more vibrant marketplace. Government officials are now having second thoughts.

Unemployment

Unemployment will likely rise as a result of the modernization that will take place through electronic transmission and handling of what were previously cash transactions. Estimates are that China currently uses 8 workers in its telecommunications services industry for every one employee typically employed by an American RBOC.

Competition Between Ministries

China is a unique environment where the ministries, the army, the party and the State Council all operate businesses. Unicom and Ji Tong, both backed to some degree by the MEI, will spur the MPT to move faster in developing networks. However, the central government has yet to draw up the rules by which the organizations are going to build China's new infrastructure. Unicom, as an example, still has problems connecting its equipment to the MPT's network. Competition between the two ministries will need to be based on ground rules if it is to result in healthy competition. The MPT continues to operate without the benefit of a telecommunications law.

Inequity Among Provinces

Approximately 850 million Chinese peasants have annual per capita incomes less than 200 dollars. Many live in rural areas. In China, the distinction between rural and urban areas has created a dualism of communications. The rapid development of voice and data networks, particularly in the coastal provinces, will increase the growing economic disparity between the interior provinces, remote western regions and the rich coastal provinces. This could create increased dissension in Beijing and pose political problems for Jiang Zemen. Areas such as Xinjiang, Tibet and Qinghai are relatively undeveloped. China's Xinjiang region in the northwest comprises half the country's area, but only a tenth of its 1.2 billion people.

The MPT recently began building a 340 km fiber-optic line from Lhasa to Xigaze at a cost of $4.4 million. Despite efforts to improve communications in remote areas telephone penetration rates vary from 2-4 percent in Tibet to 25-30 percent in Beijing.

Summary

The future of China's political system remains unclear due to the potential for significant changes in the post-Deng era. China's decision makers will be forced to choose between economic prosperity led by powerful provinces or central control and stagnant growth. China has already experienced the latter. Beijing will likely opt for market socialism to continue.

All indications are that the political risk of investing in China is well worth the cost of investment considering the potential size of the market. China's burgeoning economy and infrastructural plans will require billions of dollars worth of telecommunications equipment and services over the next decade. Assuming a smooth transition of power, control over inflation and no significant geopolitical events, China's telecommunications market is destined to become the largest in the world in years to come.

Notes

[1] Salvaggio, Jerry L., *Succeeding in China's Telecommunications Industry*, SRA, Corpus Christi, TX, 1995.

[2] In China, one's rank within an organization determines how quickly one will receive a telephone. Full professors, for example, receive telephone service faster than associate professors.

[3] Cf., "Beijing City Unveils New Expansion Targets," *Asia-Pacific Telecoms Analyst*, January 16, 1995.

[4] See "Telecommunications/Trade & Investments/Focus," *Far Eastern Economic Review*, September, 1994.

[5] Includes mobile telephone lines.

[6] *Asia-Pacific Telecoms Analyst*, Financial Times, December 19, 1994.

[7] Cf., Perry, Elizabeth J. and Wong, Christine, eds. *The Political Economy of Reform in Post-Mao China*, Council on East Asian Studies, Harvard University 1985.

[8] "Motorola's Favorite Nation," *Business China*, March 21, 1994.

[10] Brauchli, Marcus W., "Beijing's Grip Weakens as Free Enterprise Turns Into Free-for-All," *Wall Street Journal*, Aug. 26, 1993. pp.1-4.

How Banks Reengineer Through Information Technology

Vatcharaporn Esichaikul
School of Advanced Technologies
Asian Institute of Technology
Bangkok 10501, Thailand
email: vatchara@ait.ac.th

1. ABSTRACT

As a result of competitiveness, banks are entering the new era of reengineering. It is changing the way banks do business. Information technology plays a crucial role in reengineering and is a part of any reengineering effort. The purpose of this paper is to describe how banks reengineer using information technology. The reengineering experiences of some banks are discussed.

2. INTRODUCTION

The banking industry has changed dramatically over the last few years as a result of increasingly competitive pressures. Since banks must compete as never before, many of them embrace the idea of reengineering [1,2]. According to Hammer and Champy [3], information technology (IT) plays a crucial role in business process reengineering and is part of any reengineering effort as an essential enabler. The real power of information technology is not that it can make the old processes work better, but that it enables an organization to break old rules and create new ways of working.

For banks, reengineering means a radical redesign of the bank's fundamental activities for the purpose of achieving dramatic performance improvements, such as rebuilding an automated customer service, redesigning the back-office support systems, reconfiguring the check reading and sorting process, and changing the way loan decisions are made [4]. Obviously, the utilization of new information technology and service delivery systems will be needed to reengineer banking [5]. New hardware and software investments to drive the reengineering are imperative. The purpose of this paper is to examine how information technology can be used by banks to support reengineering and guide future reengineering efforts. Most banks could benefit from IT-enabled redesign of critical business processes. This paper describes four case studies of banks that have reengineered using information technology as a tool.

3. REENGINEER RETAIL STRATEGIES

To deal with increasing competition, banks need to reengineer their strategies for approaching the retail consumer. According to the marketing research, there is a growing number of consumers who are demanding alternatives to traditional branch office banking because banking at their current institutions may be inconvenient.

Huntington Bancshares

Huntington [6] realized the need to reengineer its retail strategies. The bank set up Huntington Direct, a telephone sales and service center that answers phone calls 24 hours a day, 7 days a week. The customers can have flexibility to do banking from their home, office, or even car phone. The center uses the Personal Banker Automation System, which provides a complete profile of customer relationships and comprehensive product information in order to turn bank employees into personal bankers for the retail customer. The system's feature allows personal bankers to assess which type of investment makes sense for a customer.

In 1993, the sales and service center received 1.1 million calls and opened 75,000 new accounts, nearly triple the rate of the previous year. It expects more calls because it has begun to take home-mortgage applications and to sell mutual funds by phone. Besides handling incoming sales and service calls, Huntington Direct operator also make outbound sales calls to the bank's other markets.

The bank will also take the next step in direct access banking. It will begin to reconfigure branches, taking a portion of branches and converting them into new branches. The "branch of the future" will be open 24 hours a day and will function mainly on Huntington's new release of the Personal Touch video banking machine, technology which could bridge the gap between the convenience of an automated teller machine (ATM) and the comfort of a live branch officer. The Personal Touch provides interactive video between a customer and a personal banker, substituting for real face-to-face contact. The banker is situated at the Hungtington Direct center and the machine uses dial-up telephone lines to transmit information between the center and the remote site.

4. REENGINEER BACK-OFFICE SYSTEMS

Reengineering bank processes is appropriate to the back offices of banks. Reengineering back-office support systems will increase efficiency, reduce operating costs, and make better use of human resources.

Barnett Banks, Inc.

Barnett [7] reengineers its adjustments and customer service operation. The reengineering involves automating a set of processes and procedures for correcting retail account discrepancies that have been largely manual. With the old process, when a customer comes into one of branches questioning a transaction that already took place, a branch employee records the request on the paper and sends it to one of three off-site research departments. After the request is received, the relevant transaction materials are retrieved and photocopied, the query is researched, and the adjustments are made to the customer's account, if needed. Then the results of the investigation are sent back to the branch by internal mail and the branch employee either calls or mails the result to the customer. Depending on the complexity of the request, it can take two or three days or more.

To simplify the process, Barnett is automating both the customer service (researching transaction records) and the adjustments parts to eliminate paper and to render the adjustment decision more quickly. Now customer requests for research on an item will be entered immediately into the workstation on the banker's desk. Work on the request can begin immediately because the workstation is linked to the operations center. The operations staff locates transaction records and provides the branch banker with the images of the transaction documents. Responding to a customer's research request, can now be done the same day with less labor. Two software packages are used. The first one, called CRISS (Customer Relationship Inquiry Service System), accesses account records automatically and monitors the inquiry status throughout the investigation period. The second one, called ARAS (Automated Research and Settlement System), handles account adjustments.

5. REENGINEER WORKFLOW MANAGEMENT

The focus in the banking industry has been service quality. The bank must be operating smoothly, efficiently, and productively to provide quality service. To achieve high levels of efficiency and service, many banks are finding that the workflow needs to be redesigned.

Mellon Bank Corp.

To meet the challenge of customer expectations, Mellon [8] decides to reengineer workflow management using advanced technology. The 401(K) retirement plan market demands daily valuation with instantaneous updates and service. Plan participants are demanding from Mellon the technology that allows them to more easily and accurately control their financial destiny by accessing up-to-date investment information. With the old system, client service was slower and less responsive because of nonvalue-added activities. For example, up to six copies of a document had to be produced and distributed between different floors in two separate buildings. With the new workflow management system, Mellon aims to revolutionize the way Mellon processes and services 401(K) accounts.

This new system is an intelligent system that automatically and electronically manages and coordinates information associated with each step of the process and each related department, using digital imaging to capture and display on workstations images of physical documents such as letters, forms, and faxes. The system architecture consists of an image server, PC workstations and local area networks (LAN). The new system allows processing to be done at individual workstations while providing access to multiple mainframe systems and databases. Specifically, each department captures and stores incoming client faxes directly into the system via fax modem. As for documents received through the mail, they will be scanned into the system manually. At the workstation, each image is reviewed to determine what action the account requires, entering the appropriate process codes. Then the system creates an electronic file folder, routes it to the appropriate department via LAN for further processing, and audits for missing or incorrect information. When one activity in the service process is complete, the person responsible for the next step sees it queued on his or her workstation along with processing instructions.

6. REENGINEER BRANCH NETWORK

Most banks need to reduce their proportion of high-cost, full-service branches. Effective reengineering should identify potential improvements by matching branch facilities, staff skills, and staff levels to market requirements and customer demand.

Trustee Savings Bank

UK's Trustee Savings Bank (TSB) is beginning a radical reorganization of its branch network. Every process that takes place within a branch is studied rigorously to see if the existing structures are as efficient as they can be. TSB [9] realizes that they are looking at a bigger question than simply the branch. Many separate but related functions such as banking and home loans are carried out in isolation and reported back to different subsidiaries with individual profit and loss accounts. Obviously, there are unnecessary delays and missed opportunities.

Bringing different functions under one management has changed the nature of the branches. Employees who had worked in isolation are put to work together, reducing delays and costs, and staff not required in one branch move elsewhere. Therefore, TSB can save costs and increase efficiency. The cost/income ratio has been reduced by more than 20% over three years. The savings are accomplished through changing the process and then supporting that change with automation. TSB has used reengineering methodology developed by the Wang group to restructure its business processes. They are looking at the manufacture, tracking, and delivery of all financial products requested by customers.

7. LESSONS LEARNED

Reengineering efforts do not always yield impressive results [10]. There are several reasons why it may not succeed.

1. One of the most important reasons bank reengineering fails is the inability to change.
The more rigid a bank is, the higher the risk of failure. If banks are quick to the market with the new products or are known in the market as an innovator, they tend to have the ability to change.

2. When implementing reengineering programs, banks can become frustrated because they have unrealistic expectations of what they can accomplish [11]. Some efforts are called reengineering even though they are not true reengineering programs.

3. One common mistake is launching too large a reengineering effort. For example, dozens of teams are in charge of dozens of reengineering efforts. Each team may end up accomplishing only a small fraction of its intended goal.

4. Reengineering may fail because a relatively meaningless task was chosen. The candidates for reengineering should be core processes that are important to banks such as a delivery process, which has a high perceived value to the customer.

8. CONCLUSION

To remain competitive, banks are embracing the idea of reengineering. Reengineering is a very individual process and has come to mean a wide variety of actions to different banks. Some banks may not want to reengineer the whole organization but want to redesign some aspects of existing business procedures and improve performance. True reengineering consists of rethinking the business from a blank sheet of paper by breaking down the organization and completely realigning its structure. Obviously, banks recognize and realize the potentials of information technologies; therefore, they are moving toward technological reengineering. In order to guarantee a successful reengineering, banks have to set goals that are measurable.

383

REFERENCES

1. Lian, T. (1994). The Critical Focus on Strategic Planning. *Bank Marketing*, 26(1), 4.

2. Dooner, S. (1992). What Can Customer Segmentation Accomplish?. *The Banker Magazine*, 175(2), 72-76.

3. Hammer, M., and Champy, J. (1993). *Reengineering the Corporation.* New York: Harper Business.

4. Lunt, P. (1994). Plugging Cost Holes Helps Save a Sinking Ship. *ABA Banking Journal*, 86(8), 56-59.

5. Gandy, T. (1993). Too Shy to Shake. Banker, 143(8), 77.

6. Steinborn, D. (1994). How Huntington Wields Technology. *ABA Banking Journal*, 86(6), 47-52.

7. Arend, M. (1993). Do You Really Need to "Reengineer?". *ABA Banking Journal*, 85(12), 46-50.

8. Bambarger, B. (1994). Mellon Trust Reengineers Workflow Management System for 401(K) Plan. *Industrial Engineering*, 26(5), 38-40.

9. Beck B., Shipman, A., Stern, S., and Sassees, J. (1993). Starting Over. *International Management*, 48(9), 40-43.

10. Lester, T., and Gennaoui, T. (1994). Banking Crisis. *International Management*, 49(4), 52.

11. Morrall, K. (1994). Re-engineering: Buzzword or Strategy?. *Bank Marketing*, 26(1), 21-25.

REMOTE EDUCATION NETWORK VIA SATELLITE UTILIZING 6.7 Mbps DIGITAL COMPRESSED VIDEO

Takeo Imai (a) and Atsuo Kashiwagi
(a) Satellite Communications Dept.,
Mitsubishi Electric Corp., Japan
(b) Network Application Dept.,
Mitsubishi Electric Information Network Corp.Japan

1. ABSTRACT

Mitsubishi Electric Corporation has executed a nationwide education system utilizing a digital video via satellite since July, 1990.
The system currently consists of two uplink "studio" stations and 45 "satellite classroom" stations. This paper describes the objective, training programs, network configuration of the system.

2. INTRODUCTION

For the enterprise, it is essential not only to consolidate the research and production facilities but also to enhance the infrastructure of the enterprise especially to activate and motivate its employees, and implement basic and professional education.

From 1990 onward our Company has executed the "Mitsubishi Satellite Education System" that provides the company-wide technical education, technical training for the employees in respective departments and for our customers, and company-wide events using SuperBird satellite of Space Communications Corp.

In this paper we report the objective and configuration of the system as well as its utilization.

3. BACKGROUND OF THE SYSTEM STRUCTURE

In order that we may provide our factories, plants, sales offices and the research institutes

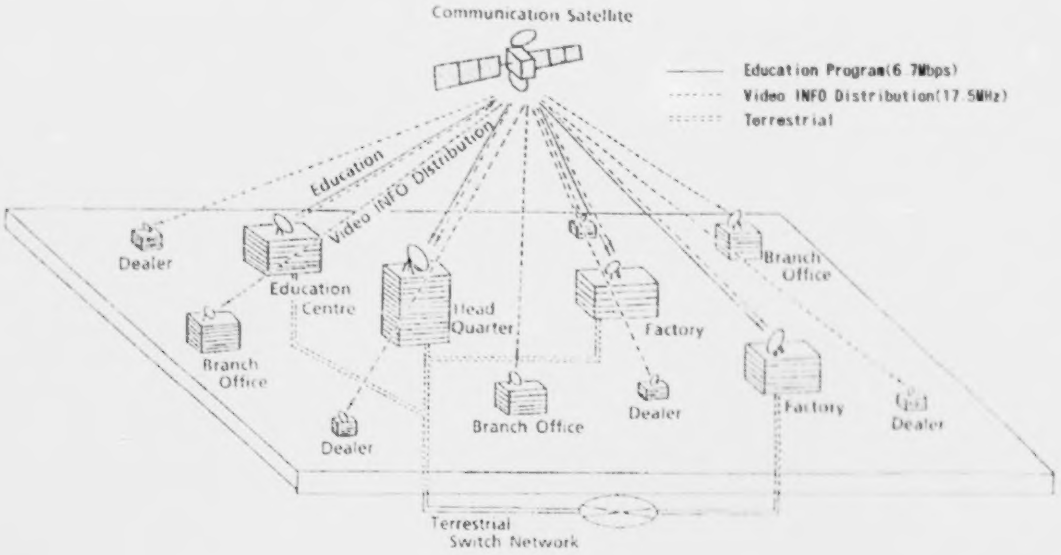

Communication Satellite
Education Program(6.7Mbps)
Video INFO Distribution(17.5MHz)
Terrestrial
Education
Video INFO Distribution
Dealer
Education Centre
Head Quarter
Factory
Branch Office
Branch Office
Branch Office
Dealer
Dealer
Factory
Dealer
Dealer
Terrestrial Switch Network

Figure 1 SYSTEM CONCEPT OF EDUCATIONAL NETWORK

deployed nationwide, with company-wide common information and equal educational opportunities, it is useful to build up a system that will make full use of the satellite communications as follows:

o Broadcast Capability:

Any information can be transmitted in real time from a transmission station to a number of receiving stations. Simple addition of the receiving station can realize the expansion of the network.

o Wide Service Area:

Since the satellite stations can be installed irrespective of the regions and geographical conditions, any information can be transmitted to anywhere within the satellite beam coverage.

o Broadband

Since the satellite transponder has broad bandwidth, one 36Mhz transponder can transfer up to two analog video or four 6 to 7 Mbps class digital video transmission system.

Conventionally our company has performed the technical education in the form of group education and training in its several training centers. Although this group method is highly effective for the technical education in factories, or for small group discussion style education, there are some difficulties when the education is to be conducted in the form of lectures for many trainees, the same courses should be held several times and a great number of educational facilities are required.

The "Mitsubishi Satellite Education System" is configured to solve such problems as above, and to establish company-wide, educational system laying emphasis on the followings:

(1) Affording equal educational opportunities not susceptible to any geographical limitations;

(2) Increase of trainees by overcoming the quantitative restrictions of educational and training facilities, equipment, and lecturers;

(3) Effective use of working hours resulting from the education at their respective duty places;

(4) The satellite system focuses on the learning in the form of lecture, while the training and education in the form of discussion is carried out in the conventional group system;

(5) The system configuration shall be so flexible that the system may be used for the relaying of such long-time programs as lecture meetings and company-wide events other than education and training.

4. NETWORK

The system using the communication satellite, SuperBird of Space Communications Corp. has the network structure as shown in Figure. 1. The network was designed laying primary emphasis on the effective use of the satellite communications circuit. From this it resulted in that the satellite communications circuit adopts the digital video transmission method to allow multi-channel program transmission. The terrestrial communications circuit (packet switched network and circuit switched network) is used for feedback link between the lecturer and trainees .

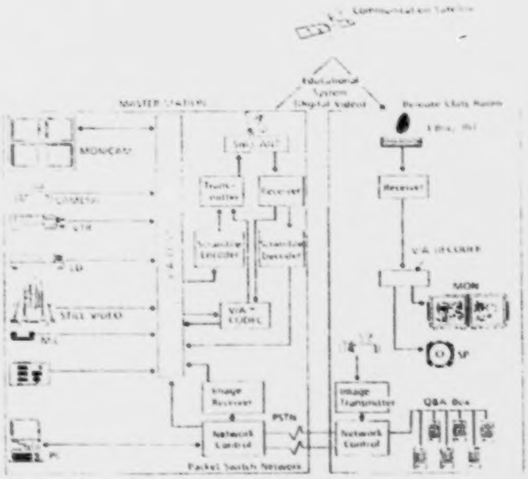


Figure 2 SYSTEM BLOCK DIAGRAM OF EDUCATION NETWORK

4.1 Network Configuration

The network features the following characteristics:

(1) The satellite video transmission system employs the digital compression technology as per MPEG-2 to make effective use of the satellite transponder bandwidth and to allow multiple number of simultaneous uplink programs upto 4.

(2) There are now two uplink stations one at Kamakura, eastern part of Japan, and the other at

Sanda,western part. The two-uplink-station configuration enables to broadcast two programs simultaneously and independently
which will enhance the system efficiency and availability.

The uplink earth station consists of 5m Ku-band antenna, 300W HPA, and related communication equipment, while the receive earth stations configured with 1.8m antenna ,LNB and digital integrated receiver decoder(IRD). The expected traffic availability over Japan is 99.9% min.

Figure 2 shows the simplified block diagram of the education system.

(3) As the terrestrial circuits, the packet switched network is used for request for question ,response from satellite classroom stations to studio(lecturer) stations, while the circuit switched network is used for the inquiry voice transmission from classroom.

4.2 System Specification

Table 1 shows the outline specifications of the network.

(Table 1)

4.3 Transmission System

4.3.1 Satellite Communications Circuit

The NTSC video and voice of the studio is compressed into one 8.6Mbps digital signal by the video CODEC (coder and decoder) VX-2000 to be transmitted to all the classrooms. While any question raised from the classrooms, the voice of the questioner transmitted through the terrestrial telephony line to the lecturer is also converted into the digital signal to be retransmitted. In the classroom the digital signal is reproduced into original video and voice by the video CODEC. Figure 3 and 4 shows the VX-2000 and simplified block diagram.

Major Performance Specification of VX-2000 Digital Codec are shown in Table 2.

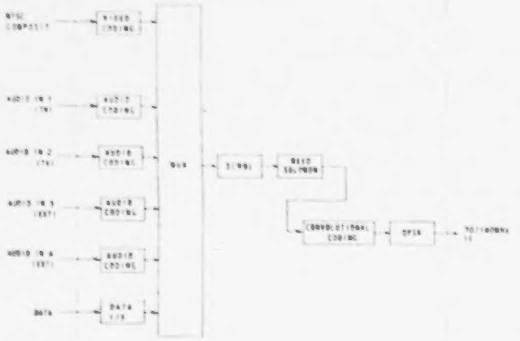


Figure 3. Block Diagram of Video Encoder

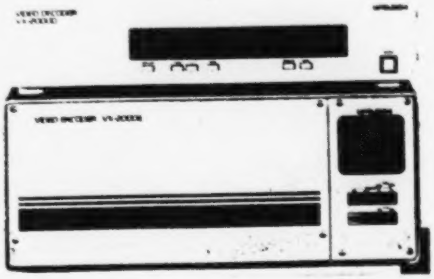


Figure 4. Video Codec

Table 1 Outline Specification of Transmission/Receiving Facilities

Frequency (Satellite link)	Uplink:14.0 to 14.5 GHz Downlink: 12.25 to 12.75 GHz
Transmission System	Digital video transmission (6.7Mbps video 1 ch/station)
Uplink Station	5m Antenna, 300W HPA,G/T 30.1dB/K
No. of Pictures	2 (1 full motion,1 still)/station
Voice Channel	128/64kbps
Studio Configuration	Lecturers' camera, still picture camera,monitor TV,Microphone,VTR etc
Receive Station	1.8m Antenna , Integrated Receiver Decoder(IRD), G/T 22.8dB/K
Satellite Classroom	Seat capacity 20 max /classroom, Color Monitor (33 inch 2 set) Q&A Box(one per every trainee)

Table 2 Specification of VX-2000 Digital Codec

ITEM		SPECIFICATION
No.of Carrier/Transponder		4
Video	System	NTSC Composit Analog
	Bandwidth	4.2 MHz
	Coding	Motion Compensation/DCT/VLC
	No. of Channels	1
	Information Rate	6.7 Mbps
Audio	System	Analog & AES/EBU Digital
	Bandwidth	20 kHz
	Coding	per MPEG layer 2
	No. of Channels	4
	Information Rate	128 kbps/ch
Data	No. of Channels	Low Speed x 1ch, High Speed x 1 ch
	Information Rate	19.2 kbps, 256 kbps
Total Information Rate		7.6 Mbps
Error Correction		Reed Solomon Coding Convolutional Coding Viterbi Decoding, R=3/4
Modulation		QPSK
Transmission Rate		10.9 Mbps
Transmission Bandwidth		6.6 MHz

4.3.2 Terrestrial Communications Circuit

To establish an interactive effect,the system allow the studio to accept the request for question, answer to the question, and vocal question. To achieve this most effectively and economically,the terrestrial communications circuit is used as follows.

(a) Use of Packet Switched Network

Collection of such data as request for question and answer to question in the classroom are supposed to be small in quantity, and the data production frequency is low. The packet switching network is used to make data collection by polling from studio to classroom. Depending on the educational contents the classrooms receiving the lecture are registered beforehand in the studio, and the collection of data is made from the classrooms thus registered.

(b) Use of Telephony Circuit Switching network

When the Q&A is conducted after accepting the request for question from classrooms, the transmission line is laid between the studio and the classrooms making use of the circuit switching network.

4.4 Studio and Classroom

The equipment for studio and satellite classroom are the critical factor having influence over the educational effects both for lecturers and trainees.

4.4.1 Studio Dedicated to Education

The system has a studio for exclusive use of education and training, which is of very simple configuration as shown in Figure 5.

(1) Instructor Box

This box allows the lecturer to select pictures and voice by means of hand manipulation, send and monitor them, while giving the lecture. Panning and zooming is effected on the lecturer camera as well as zooming of writing/picture camera.

(2) Lecture with Two Pictures (still and moving)

The moving pictures are used for such moving objects as lecturer and for video images, while the still ones are used for text, drawings, table and any other objects.

(3) Information Interchange with Satellite Classroom by Q&A System

By means of the control with the personal computer (PC) installed in the studio, the lecturer can conduct, for all the trainees in the satellite classrooms, "calling the roll", "accepting a request for question", "giving permission for question", "collection of replies to the alternative questions", and "taking in the still pictures of classrooms".

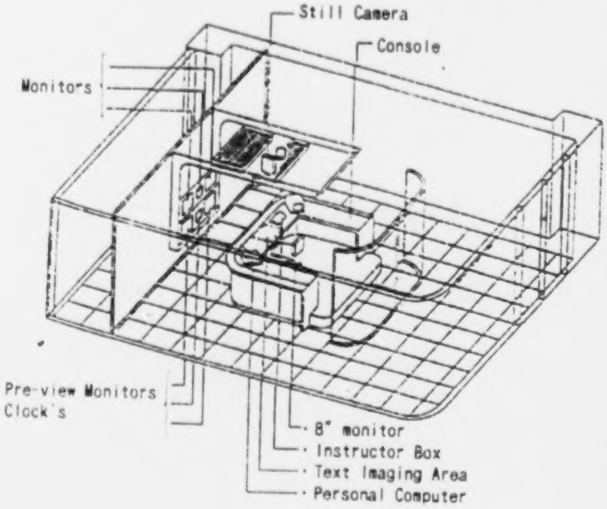


Figure 5 Configuration of studio

4.4.2 Satellite Classroom (Figure 6)

The satellite classroom is provided with the following equipment so that the trainees may have necessary and satisfactory communications with their lecturer in studio.

(1) Large Screen TV (2 sets)

One unit of lecture may last for 3 to 4 hours which requires a confortable educational environment such as lectures under normal lighting (outer daylight from windows, bright illumination). To that effect 33-inch direct viewing TV sets are used both for moving and still pictures.

(2) Q&A Box

Each trainee has a Q&A box, through which the trainee can communicate with the lecturer in studio.

(3) Classroom Camera

Each satellite classroom has a classroom camera that transmits the scene of the classroom to the studio in still picture through the terrestrial telephony line.

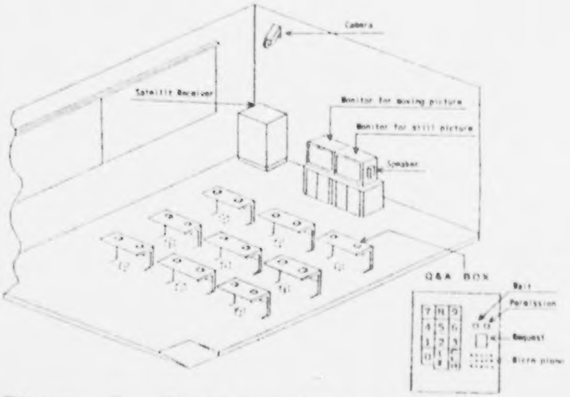


Figure 6. Classroom Configuration

5. OPERATION

5.1 Typical Course of Operation

The course of satellite education is roughly divided into three phases: lecture, Q&A, and alternative questions .

(1) Lecture Phase

The lecturer give one way lecture through two images (motion for lecturer,still for text pictures) and one voice via satellite. Careful consideration is however given so that any trainee should never feel the sense of alienation by allowing the remote trainee's questions through the terrestrial communications circuit. The lecturer can know, by means of the TV monitor in studio, the atmosphere of the distant classrooms ,through the terrestrial communications circuit.

(2) Q&A Phase

When any trainee presses down the question button on the Q&A box to transmit the request for question, the lecturer can recognize the request on the personal computer terminal, and if the lecturer gives permission signal through the personal computer , the voice of the lecturer and that of the trainee will be transferred through the satellite communications circuit and through the terrestrial communications circuit, respectively. The questions and answers under these conditions are transmitted to other TV classrooms by way of the satellite communications circuit from the studio uplink station..

(3) Phase of Alternative Questions

The lecturer sets some alternative questions and the trainees choose correct button among the o to 9 buttons on the Q&A boxes. The results are gathered and summarized by the personal computer in studio through the terrestrial packet communications circuit.

The educational effect has been so enhanced making full use of the advantages of this bi-directional system that the lecturer can advance her or his lecture grasping well the level of understanding of the trainees and that the consciousness of engagement of the trainees may be elevated and their state of tension duly maintained.

5.2 CONTENTS

As shown in Table 3, the use of satellite educational system can roughly be divided into two: for educational use, and for such program relaying use as lectures and company-wide events. The educational use occupies the most part of the time.

389

Table 3 Use of Satellite Educational System

Application		Contents
Education	Company-wide	Guiding course: Quality Control, IPR Cost Control, Inventory Control Accounting, etc. Technical course: Elementary techniques (mechanical,electrical,communication)
	Division-by-Division	For customers: Introduction of products, guiding course on computer and communication. For employees: Basic course on products related technical knowledge.
Program Relay	Company-wide Event	national convention of small group activities, etc.
	Forum/Debates	Company-wide items such as environmental issues or QC
	Lecture Meetings	Lecture meetings by external lecturers

5.3 Frequency of Operation

The number of use days and time has by far increased due to the fine tuning of the system, enhancement of the lecture contents and lecturing method, increased number of receiving classroom, improvement of the digital moving picture quality by employing 6.7 Mbps MPEG-2(initially the system started with 1.5 Mbps H.261 video) and to the company-wide encouragement of use.

The yearly use days has amounted to 200 days and the total operating time to 2,000 hours (600 courses approx.) of program broadcasting (time for rehearsal and preparation excluded).The annual operation rate (number of days) is approx. 60%.

The number of participants to the educational programs is 50 to 200 persons per course depending upon the contents of the courses, and those to the relay of company-wide event is over 900 persons/event.

5.4 Effects

The satellite education has displayed higher effects than conventional group education in regard with the following four points:

a) Increased number of trainees (2.5 to 10 times)

b) Mitigated load of lecturers (they need not give the same lecturers repeatedly any more)

c) Reduced time of traveling, since the trainees can participate in the lectures at the respective places to which they have been posted.

d) Curtailed expenditures such as traveling and accommodation fees.

6. FUTURE ISSUE

a) Since the current operation rate having reached 60% with two program transmission capability with two uplink stations, the increased demand for future satellite education should be coped with by simultaneous transmission of further number of programs with the third and fourth transmission stations.

b) To protect the company intellectual property, the security control is required to be enhanced.

c) Enhancement of the system architecture to fit with the updated mullet-media environment with utilizing data transmission capability of MPEG-2 system is under preparation.

d) The tone quality of the vocal inquiry from the satellite classroom to the lecturer through the terrestrial circuit shall be improved. For this and multi-media application, bi-directional system via satellite is under consideration.

REFERENCES

1) Shuhji Hasegawa, Atsuo Kashiwagi, et al.: In-house Education using Satellite Communications and Video Information System, Mitsubishi Electric Corp. Technical Report, Vol. 64, No. 8, 1990, Mitsubishi Electric Corp. (1990)

2) Yoshitomo Sakato, Gen Sasaki, et al. Video Codec for Digital SNG System,ITE Technical Report , Vol.17,No.13.1993.

New Information Communication Network In Multimedia Age

Kuniko Shimizu Takayuki Hirakawa
FUJITSU LTD.
OSAKA JAPAN

The municipal government of the City of Izumo has built a multimedia network capable of delivering information to 9,000 families which is intended to fostering the next-generation of farmers and to activate local activities. The system converts a variety of data, including database records, videotex information, text data, and image data, into a uniform fax format. The system gives subscribers ready access to information through easy to use, inexpensive fax terminals.

This paper describes the development objectives, features, services available, and future plans for the system.

1. Background

1.1 Location

The City of Izumo is the second largest rural city in Shimane Prefecture at the west end of Japan's Honshu Island. It has a population of about 83,000 or about 25,000 families.

Its principal industry is agriculture, with wet rice accounting for the greatest portion of the crop. In recent years, however, a transition towards a hybrid style of agriculture has been in progress. Farmers are now combining wet-rice farming with other types of farming including: vegetable, flower, fruit (such as grapes and melons), and even dairy. Even though it is the time- honored origin of many Japanese myths, Izumo has a mix of characteristics, both the traditional and the modern. The citizens are innovative and independent.

1.2 Changing Agricultural Environment

The recent history of Japanese agriculture has involved a narrowing, aging population of full-time farmers, which is due to:

- Inexpensive agricultural imports eroding domestic demand.
- The fact that farmwork is very hard and involves a lot of labor per day and very few holidays.

1.3 Changing Information Needs

1.3.1 Flow

Citizens' and farmers' needs for information have been changing. The one-way transmission of information, from the top of an organization to the bottom, used in the past, is no longer satisfactory. People need a two-way exchange of information from the top of an organization to the bottom and vice versa. This applies within a town, between groups, and between individuals.

1.3.2 Media

The types of information media that are required are also being transformed. Until now, information from the City of Izumo to its citizens has been more or less limited to verbal information given by means of one-sided, uniform broadcasts.
But now, paper-based information is important because:

- It can be stored.
- Written information (characters, illustrations, and charts) is often better for fast, precise understanding.

1.3.3 Availability/Timing

The transmission of information by broadcast does not necessarily provide farmers with information when it is needed. This is because the suppliers of the information send it out only when they think the farmers want or need to know. Now it is more important, however, that anybody who needs information can get it instantly and that the procedure to get the information should be as easy as possible.

2. System Overview

2.1 Objectives

The system has been built with a view to achieving the following objectives:

- Local activation
  Local communication flow can be facilitated and increased by responding to changes in the need for various types of information, thereby enabling local residents to live with an increased sense of community and integrity.

- Fostering next-generation farmers
  The system will focus on the agriculture industry to expedite information flow with regard to farmwork, thus enabling farmers to remain profitable by keeping prices and quality comparable to imported agricultural produce. Labor-intensive yet efficient farmwork can ease the labor workload an individual farmers. The system will also help to create a living environment for farmers that surpasses urban comfort.

2.2 Organizers

The system has been built at the initiative of JA Izumo, the City of Izumo Agricultural Cooperative Association. Beginning with discussions in 1990, JA Izumo first brought the system into service in January 1995. The system has been running successfully for about six months now. About half of the cost of the system has been paid by the Government of Japan, Shimane Prefecture, the City of Izumo, and JA Izumo, with the rest being paid for by residents of the City of Izumo.

2.3 System Configuration

2.3.1 Network configuration

The system is a network of digital exchanges and broadcasting facilities which are installed at 34 points within the City of Izumo. These points are then connected by dedicated circuits to 9,000 families throughout the city. These circuits have been laid exclusively for the system.

2.3.2 Center configuration

The computer room at JA Izumo houses digital exchanges, the main broadcasting facilities, and the following devices which are interconnected by a LAN (under TCP/IP and NetWare protocols):

- Host computer (for handling the existing needs of JA Izumo)
  Manages local resident information, such as savings account information and agricultural produce information.

- Host computer (for this system)
  Automatically generates or translates the information that is to be provided by the system (converts information from text data into fax image data).

- Multimedia storage unit (system use)
  Stores fax image data and voice data.

- External information translator
  Automatically retrieves information from an external database periodically and translates it for distribution by fax.

- Personal computer
  Used to generate information interactively.

2.3.3 Families

Each family site has an information terminal which includes: fax, telephone, and a broadcasting speaker, so that residents can provide and retrieve information.

Figure 1 illustrates the system configuration.

3. System Features

3.1 Fax Terminal (Information Terminal)

Since Japanese people have, until very recently, only used writing implements, such as pens and pencils, to write

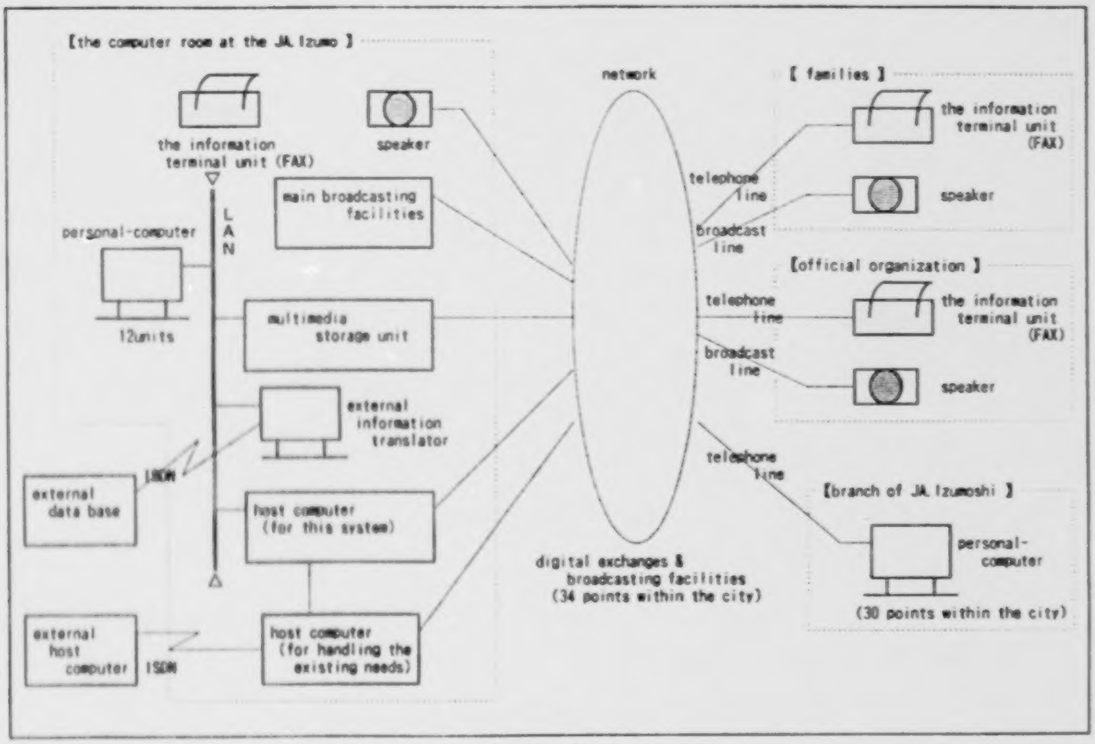

【the computer room at the JA Izumo 】
the information terminal unit (FAX)
speaker
main broadcasting facilities
LAN
personal-computer
12units
multimedia storage unit
external information translator
ISDN
external data base
host computer (for this system)
external host computer
ISDN
host computer (for handling the existing needs)
network
digital exchanges & broadcasting facilities (34 points within the city)
telephone line
broadcast line
telephone line
broadcast line
telephone line
【 families 】
the information terminal unit (FAX)
speaker
【official organization 】
the information terminal unit (FAX)
speaker
【branch of JA Izumoshi 】
personal-computer
(30 points within the city)

Figure 1

characters, many, particularly those aged in their 40s or above, recoil at the thought of working with keyboards. To avoid this fear, the system uses a fax terminal as the information terminal at each family site. With a fax terminal, anybody can retrieve information by simply using a set of 12 keys, which include numbers 0 through 9, *, and #.

The fax terminal:

- Enables those users who tend to feel uncomfortable with computers, to manipulate the terminal with ease.
- Gets information through to users in more depth than with verbal information as it is presented as characters, illustrations, and charts.
- Retrieved information can be stored.

Although the information terminal also serves as a telephone, it does not ring when it receives faxes. This feature:

- Allows automatic distribution from the center at night.
- Prevents incoming faxes from being confused with incoming telephone calls.

3.2 Customer-Owned-and-Maintained Network

With a customer-owned-and-maintained network of dedicated circuits:

- Subscribers can be charged a flat monthly rate, rather than by the number of hours and users can use the network for as long as they like, without worrying about the charges.
- Allows subscribers to use the system at the moment of need, without being influenced by the traffic of other systems.

3.3 Standardized Operations

A single information terminal provides access to all the information. Procedures for retrieving information of any kind are standardized so that there is no subscriber confusion.

Users can get information by simply keying in its number, without having to know where the information is stored or on what media.

3.4 Automatic Information Entry

To ease the system users' workload, all of the procedures for entering information into the system from external databases are automated.
The external information translator automatically accesses external databases once every hour, and searches through the database for information according to a predefined set of search conditions. After obtaining the information, the external information translator translates it to fax image data and stores it, with an assigned menu number, in the multimedia storage unit.

This scheme:

- Improves user satisfaction because the latest information is constantly available in the system. This user satifaction then promotes access to the system (for example, if only obsolete weather information was available, users would be less eager to access the system).
- Lessens the administrators' workload, thereby facilitating the addition of new types of information.

3.5 Broadcasting Equipment/Computer Linkage

Because of an advanced linkage between the broadcasting equipment and the computer:

- Broadcasts can be restricted to specific towns, school districts, wards, etc. and transmitted to or from information terminals.
- Broadcasts are automatically recorded by the information terminals.

3.6 Intelligent Broadcasting Equipment

Intelligent broadcasting equipment offers enhanced scheduling, error recovery, automatic operation and other facilities.

4. Typical Services

4.1 Broadcasting Service

This service involves broadcasts from the center broadcasting equipment or from public institutions and family sites in the city. The broadcasting service has the following features:

- Programs recorded and edited at the center are broadcast three times each day at specific times in the morning, at noon, and in the evening.
- Broadcasts may be directed from public institutions, such as the center, the police department, fire department, city office, and schools, or from family sites as needed.

Table 1 indicates the various kinds of broadcast.

Kind of broadcast	Source	Timing	Coverage
Emergency broadcast	JA Izumo	For emergencies	All districts of the city
Simultaneous paging	Police department, fire department, city office	For emergencies	All districts of the city
From the broadcasting console	JA Izumo	When needed	Selected districts
Regular simultaneous	JA Izumo	Three times each day, morning, noon, and evening	All districts of the city
Regular local broadcasting	JA Izumo	Three times each day, morning, noon, and evening	Different information broadcast to the 17 district of the city

Table 1

4.2 Information Availability

The system has an information retrieval service by which users can retrieve information on their own, and an information notification service which delivers information to users automatically.

4.2.1 Information retrieval service (about 100 categories)

1) Savings balance inquiry
Users can retrieve the balance of their savings accounts and details of their transactions for the last month.

2) Weather information
Users can receive the latest weather information (air temperature, rainfall, snowfall, and weather forecast) and weather maps as they are updated every hour.

3) Vacancy information
Users can retrieve information about the availability of reserved seats on planes and trains up to one month ahead (but cannot make reservations).

4) Agricultural information
Users can retrieve the latest crop market information, cultivation technologies, pesticide information, and other agricultural information.

5) Various notices
Users can retrieve notices issued from public institutions, such as the police department and fire department.

4.2.2 Information notification service (three categories currently available)

1) Bills payment notification
The system notifies subscribers of the sale of their agricultural produce by JA Izumo.

2) Silo information
Rice produced by subscribers is stored in a common warehouse, called a silo. The system notifies subscribers of the quantities, classes, quality and other relevant characteristics of the rice which has been received by JA Izumo.

3) Various notices
The system faxes various other general information, which originates from JA Izumo or public institutions, to the subscribers.

4.3 Information Exchange Services

The information terminals used in this system may also be used to exchange information between subscribers.

4.3.1 Fax communication

Subscribers can use the terminal as a standard fax to exchange documents with one another.

4.3.2 Group bulletin board

The multimedia storage unit at the center has areas set up for certain groups. Access to these areas is restricted only to the subscribers in the group. Group members are also allowed to enter information to be shared. (Access by other subscribers is prevented.)

4.3.3 Telephone

Subscribers can use their fax terminal as a regular telephone.

5. Evaluation

It is still too early to evaluate whether the objectives mentioned in Section 2.1 have been accomplished. However, the system is being used so frequently that the usage rate is running above the initial design expectations. This usage is a good indication that the system objectives will be realized.

6. Future Plans

Plans are underway to expand the variety of services provided by the system by:

- Expanding the categories and volume of information available for greater subscriber convenience. Particularly, efforts will be made to enhance the range of agricultural information in order to help modernize agricultural production further.

- Connecting the network to the districts surrounding Izumo to broaden the coverage of services and increase the population of subscribers.

7. Nationwide Trends

At present, about 200 cities and districts across Japan are contemplating building new local information communications systems. Many of the systems being examined are based on fax terminals (like those used in the City of Izumo) or on CATV. The success of the system in Izumo may encourage further use of this or other systems.

Two-way interactive advertising in the information society

Kazumoto Inuma
NEC Corporation

Abstract

Information providers in the coming information society should be increasingly urged to create information systems that are attractive and user-friendly. Advertisers are expected to support the content producers financially as well as to develop a more customer-oriented and cost-effective advertising paradigm that uses new information infrastructures. As typical examples, we propose and discuss three interactive advertising systems: navigational television, the "infomercial" and on-line advertising.

1. Introduction

The world is moving towards what might be termed an "information society". Most people would not question this inevitable fact. Rather, the question is how fast and in exactly what way the information society will become a reality. In this paper, we will present an overview of the technological revolution that underlies the realization of the information society. We will then propose the paradigm of "two-way interactive advertisement" for effective implementation of that technology.

The concept of the Information Superhighway has driven the information technology industry to start building two-way interactive cable systems throughout the nation. This will provide the general public on-demand access to various goods and services through two-way cable networks available directly at their homes. What impact will the availability of such on-demand access have on the advertising industry?

Current advertising expenditures are predominating in television and newspapers. This does not necessarily mean, however, that customers are satisfied with the presently available modes of advertisement. They are more than likely forced to watch TV commercials by default, simply because they do not have access to on-demand services. With two-way interactive systems at hand, on-demand services will become widely available in the near future, allowing consumers to access only what they desire, when they desere it. This will force us to drastically alter our approach to advertising .

In particular, it will be imperative that we consider a new mode of advertising — "two-way interactive advertising". We propose the following possible scenarios within this new paradigm of advertising.

(1)Navigational television systems that give us one-touch connection to the on-line database referenced in the TV commercial.

(2)The so-called "infomercial", which provides information that is more customer oriented as well as being exciting and entertaining, and creating a sense of intimacy with the viewer.

(3)On-line advertising, which offers key advantages to vendors for establishing and maintaining dialogs with customers.

2. Moving toward two-way interactive systems

Three major items of technology can be named that were invented this century: the semiconductor, the computer, and the laser. DRAM storage capacity has quadrupled every 3 years, corresponding to roughly a 1000 -fold increase in 15 years. This growth trend is expected to continue well into the 21st century. Computers also are improving rapidly. Personal computers have become 1000 times more powerful, in terms of their computing speed and memory capacity, over the last 15 years. Installation of optical fibers has become widespread improving dramatically the quality of long distance telecommunication. A single optical fiber has the capacity to handle as many as 3 million TV channels. Figure 1 shows the typical technical improvement factors expected in the time period between 1985 and 2000. The technological revolution is expected to satisfy the demanding requirement for the storage and transmission capacity necessary to implement two-way interactive multi-media networks and systems.

Information flow increases with time. Big information explosions occur in conjunction with big technological inventions. As shown in Figure 2 the first explosion accompanied Gutenberg's invention of the printing press. Information flow was greatly expanded by printing technology. The second was the invention of the steam engine. Information flow was accelerated by transportation. The third came with the invention of the telephone and television. Telecommunications enable information transfer without wasting energy. The fourth information revolution will occur through installation of information superhighways and multimedia systems. This might be called the "information technology" (IT) revolution, and enables interactive communications.

Nippon Telephone and Telegraph (NTT) has been planning the installation of a national optical network infrastructure, to be completed by the year 2010. The total investment announced is $330 billion, excluding maintenance. Digital television systems have also been introduced to provide more than 100 TV channels. Therefore, the fourth revolution is not a dream. It seems to be here already.

Figure 3 shows the present status of my home in Tokyo. There are three different on-air TV transmission services — by terrestrial microwaves, by broadcast satellite, and by communication satellite — each requiring a different type of decoder. Most people have a VCR, a CD player, and a video game player. Each piece of equipment has its own remote controller, which is often confusing and not easy to use. Adding to the confusion, newspapers and direct mail are also always piling up in the living room.

We are projecting the new services indicated on the right hand side of the figure — that is, every service provided via a two-way cable and selected through the decoder with a common remote controller. What are the benefits of these systems? Owing to the two-way interactive cable system, we can get more up-to-date information at any time. We do not need to obtain separately a video tape, a CD, and a videogame. Moreover, it is a complete system, that encompasses all media and also provides the benefits of using less energy and space and being easy to use.

3. Roles of advertising

From the technological revolution point of view, the information infrastructure can certainly be achieved. However, problems still remain : Who provides the information? Who pays for transmission of the information? Advertising will play a key role in solving these problems.

In the U.S. and Japan, most of the television and radio broadcasting expenditures are supported by advertisements. Japan's NHK (national TV) and 90% of U.S. cable TV costs on the other hand are paid through subscriptions. Newspaper and magazine costs are also shared between advertisements and the cover price. The total advertising expenditure for in 1993 is about $38 billion and $92 billion in Japan and in the U.S., respectively.

Figure 4 shows media costs share comparisons between Japan and the U.S.. There are some differences in advertising contributions. The Japanese advertisement share is greater than the U.S.'s for broadcast media, but smaller for print media. It is quite significant that 60 to 70% of media costs are supported by advertisers. Since this structure will not change dramatically in the future, information content will be dictated by advertisers. However, advertisers will focus on a more customer-oriented and cost-effective advertising paradigm that uses new information infrastructures.

4. Two-way interactive advertising

With the ever-increasing quantity of new goods and services developed every year, it is becoming harder and harder for consumers to look for what they desire in the market. It is also difficult for the providers to reach the consumers and inform them of their selling points. We envision a two-way interactive advertising paradigm to bridge this gap that exists between the consumers and the providers, thus making the coming information society genuinely beneficial for both parties.

As its goals, advertising draws attention, provides information, compels buyers to take action and, moreover, communicates with customers to engender repeat orders. Conventional advertisements are evaluated with these goals shown in Figure 5. A TV commercial is excellent in drawing attention but poor in providing ample information to customers. A catalog can provide good information and an easy way to place orders, but is poor in drawing attention and communicating with customers. Interactivity is a key issue in improving advertising. We propose the following as new interactive advertising systems: navigational television, the infomercial, and on-line advertising. Details are discussed in the next section.

4.1 Navigational television (Navi-TV)

Figure 6 illustrates the navigational television systems concept. This concept improves conventional TV shopping by providing to the customers an automatic dialing capability for accessing the vendors. The TV shopping program broadcasts a vendor's database address and commercial ID in digital format synchronously with the commercial video transmission. Such information can easily be multiplexed during TV blanking intervals or digital television signal bit streams. If a customer is interested in the product or service, he can press his keypad to access the database. A decoder installed in the Navi-TV processes all necessary operations automatically.

A typical example of sending and receiving protocols is shown in Figure 7. After connecting with the database, negotiation procedures are displayed on a Navi-TV window screen. Concurrent voice communication will also be available during the negotiation to assist and advise the customer. Navi-TV systems can provide an on-line interactive communication capability in addition to conventional TV commercials. Thus, the systems can provide more goal-oriented advertising. Navi-TV can also be applied to other various applications such as quiz shows, inquiries, and ticketing etc.

Moreover, it is possible to shorten the commercial time while providing enough advertising effects through Navi-TV. For example, if advertisements insert the following ending message instead of annoying comercials after a 30-minute attractive drama, what impression will the viewer have?

"If you are interested in the drama we sponsored, just press your keypad, please". It can create a sense of intimacy with the viewer.

4.2 The "infomercial"

Advertisers will provide more customer-oriented information. Namely, the so-called "infomercial" will be promoted. The channel transmission fee will be reduced considerably so as to allow the advertisers to buy enough commercial time to provide infomercials. The "technology revolution" described above should make this possible by increasing the TV per-household channel capacity up to 500 or 1000. If the per unit cost of a 30-minute infomercial becomes comparable to that of a one-page magazine advertisement ($1,000 to $3,000), vendors and enterprises will use the advantage to inform customers in detail about their products' selling points.

A future multi-channel TV program design is illustrated in Figure 8, where a 2.4 Gb/s fiber to the home (FTTH) transmission is assumed. TV programs will be more specialized in order to satisfy a variety of personal interests. In this design, the total number of TV channels is assumed as 750, of which 50 channels are pay channels, 100 are conventional commercial channels, 200 are business programs and 400 channels are assigned to infomercials. Some of the channels can be used for providing on-demand or near on-demand services. The best infomercials are exciting and entertaining, and create a sense of intimacy with the viewer.

The 400-channel network would potentially be able to provide 5,840,000 30-minute infomercial units per year : 40 (units/day) × 365 (days/year) × 400. If the cost of a 30-minute infomercial is assumed as $2,000, advertisements on 400 channels would bring in $11.7 billion per year. If commercial TV channels and business program channels also bring in income of the some order, this will make $ 35 billion per year. This could compensate for cost depreciation in the optical network investment of $330 billion in 10 years.

4.3 On-line advertising using the Internets WWW

Advertisers will provide on-line interactive services so that the consumers can access what they desire when they desire it. The Internet's WWW (World Wide Web) is the most promising network for providing on-line advertising. On-line newspapers and on-line magazines (called "digizines") have recently appeared and are gradually increasing. On-line shopping and on-line cashing are also expanding.

Figure 9 shows personal computer market growth compared to TV and VCR sets. The PC growth rate is higher than that of the TV such that there will be a PC in almost every household by 2005. By this time, on-line network access will have become as popular in every household as the TV is now.

The advantages of on-line advertising are :

1) It can establish and maintain dialogs with customers.
2) It is closest in style to personal selling.
3) It offers unlimited space and time availability.
4) It can encourage communities of users to share experiences, support, and common interests.

On-line advertising, however, is poor in drawing attention from huge numbers of people. This will promote development of systems that combine on-line and Navi-TV.

5. Conclusions

Supported by the current technological revolution, information infrastructures will be a strong influence in creating an information society. During this process, information providers should be increasingly urged to create attractive and user-friendly information systems by introducing reasonable social mechanisms. Advertising accounts for 60 to 70% of present media costs, and this structure will not change dramatically in the future. However, advertisers will focus on a more customer-oriented and cost-effective advertising paradigm that uses new information infrastructures. The present modes of advertising cannot establish dialogs with customers.

The two-way interactive capability is a key factor in achieving advertising goals. In this paper, we have proposed three new interactive advertising systems. They are : navigational television, the infomercial, and on-line advertising. With the ever-increasing quantity of new goods and services, it is becoming harder and harder for customers to look for what they desire in the market. It is also difficult for providers to reach customers and inform them of their products' selling points. We envision the two-way interactive advertising paradigm as bridging this gap, thus making the information society beneficial for both advertiser and consumer.

Acknowledgments

I would like to thank Yutaka Nakanishi for obtaining very useful advertising information.

References

(1) Veronis, Suhler & Associates, Five - Year Out - look. Advertising Age, July 25, 1994.

(2) W. Wada, New ad Markets and media variations. Japan Marketing Journal 56, 1995.

	Improvement factors expected between 1985 and 2000	Typical examples	
		1985	2000
Transmission speed	1,000~100,000 times	9.6Kbps Modem	156Mbps B-ISDN
Storage capacity	1,000~ 10,000 times	1MB Floppy disk	10GB DVD
Processing speed	1,000~ 10,000 times	1MIPS Cisc cpu	1000MIPS Risc cpu

Fig. 1 Advances in Information Technology expected by the year 2000.

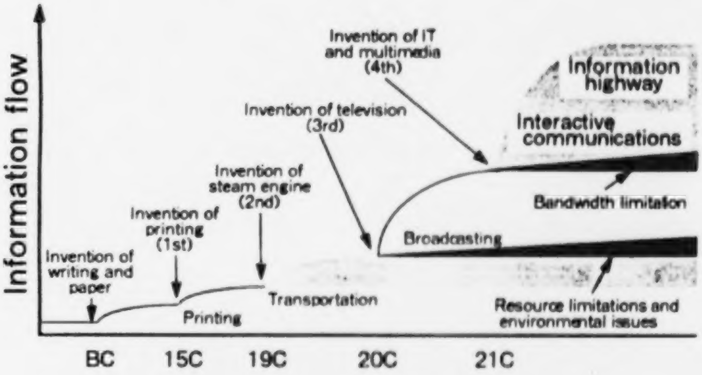


Fig. 2 Moving toward the fourth information revolution.

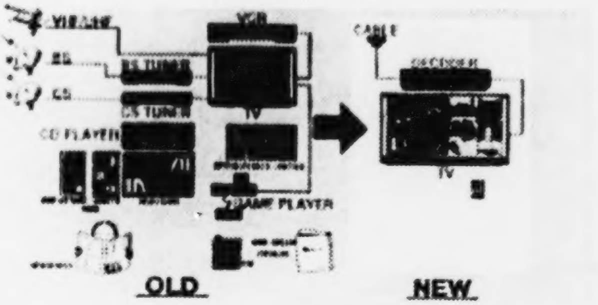

VHF/UHF
BS
CS
BS TUNER
CS TUNER
CD PLAYER
VCR
TV
GAME PLAYER
CABLE
DECODER
TV
OLD
NEW

Fig. 3 Merging Media in a two-way cable.

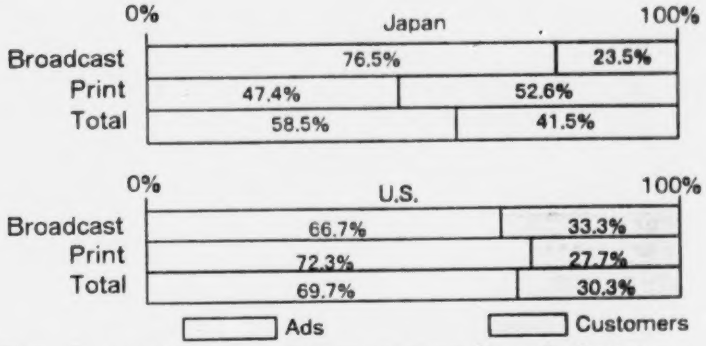


Fig. 4 Media costs share comparison between advertisers and customers in 1993. Broadcast includes TV, CATV, and radio. Print includes newspapers and magazines.

Goals / Modes	Draw attention	Provide information	Take action	Communicate with customers
Commercial	O	×	×	×
Catalog	×	Δ	Δ	×
Navi-TV	O	Δ	O	Δ
Infomercial	Δ	O	Δ	Δ
On-line advertisements	×	Δ	O	O

O Excellent Δ Good × Poor

Fig. 5 Evaluation of advertising goals and modes.

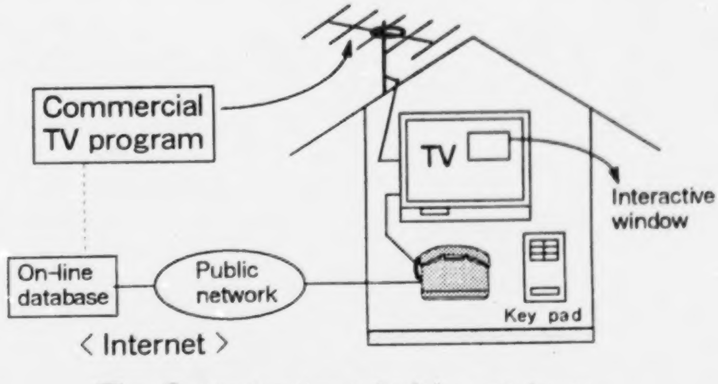

Commercial TV program
TV
Interactive window
On-line database
Public network
Key pad
< Internet >

Fig. 6 Navigation television systems.

Sequences	Typical navigation protocols	Signal directions
1	Start automatic dialing	→
2	Proceed with login protocols	←→
3	Send commercial ID	→
4	Send customer information	→
5	Receive guide information	←
6	Start negotiation sessions	←→

Fig.7 Navigational TV protocols. Arrow(→) shows signal direction from a subscriber (left) to a database center (right).

Categories	Content examples	Number of channels	Required bit rates	Supported by
Pay TV	Movies Sports Music	50	12Mb/s/ch. (0.6Gb/s)	Customers
Commercial TV	News, Sports Dramas, Movies Events, Music	100	6Mb/s/ch. (0.6Gb/s)	Advertisements
Business program	Shopping Travel arrangements Ticket ordering	200	3Mb/s/ch. (0.6Gb/s)	Advertisements / Vendors
Infomercial	Fitness machines Kitchen helpers Compact discs	400	1.5Mb/s/ch. (0.6Gb/s)	Vendors
Total		750	2.4Gb/s	

Fig. 8 Future multi-channel TV program designs and their sources of income.

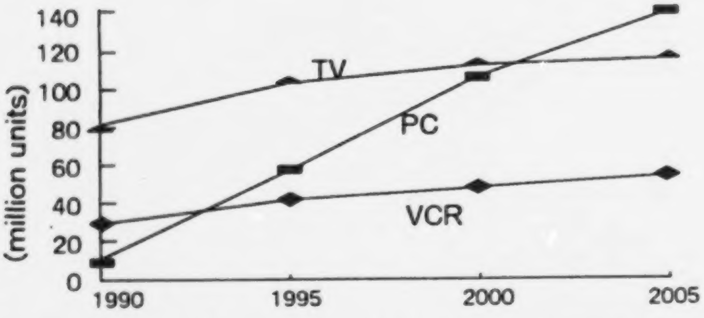


Fig. 9 Personal computer market growth compared to that of TVs and VCRs. The market includes the U.S., Europe, Japan, and Asia.

Internet Development in the Asia Pacific Region: Challenges to Implementation

Sarah S. Lee
Interdisciplinary Telecommunications Program
The University of Colorado at Boulder
Boulder, U.S.A

Abstract

Like other parts of the world, Asia Pacific Internet also experiences exponential growth in the last few years. Along with the rapid expansion of the Internet are the challenges which Asia Pacific networking community must face to ensure successful implementation of the Internet. As this paper will demonstrate, the real challenge is not technical or financial, but political and cultural.

1. Introduction

For more than a decade, dynamic transformation in information technology has dramatically altered the way we live and conduct businesses. Access to critical information is often credited as the driving force to economical growth and autonomy.

As information transcends national boundaries, achieving interconnectivity and interoperability across heterogeneous telecommunications infrastructures become key challenges yet to be resolved. Such challenges are particularly evident within the Asia-Pacific region where developed and developing countries coexist. Realizing the importance of information and its critical role in world economy, countries in the Asia Pacific region valued interconnectivity of networks and interoperability of services as top national priorities.

Meanwhile, due to limited scope of this paper, Internet will be the main internetworking scheme under evaluation. Though Internet-style processes may not be sufficient in a broader internetworking environment, it is a good starting point to demonstrate how standards and practices can work to achieve interconnectivity and interoperability.

This paper will analyze the development of the Internet in the Asia Pacific region by first providing an overview of the region's current telecommunications infrastructure. Then, a section will be devoted to provide statistical background regarding the growth of the Internet in the Asia Pacific region. Following will be specific case studies on a country to country basis. Next, the paper will demonstrate why AP networking community should adopt Global Internet Exchange (GIX) as a model for internetworking. Finally, this paper will conclude by addressing the real challenges to full implementation of the Internet in the Asia Pacific region. High level recommendations will be given in an attempt to facilitate successful deployment of the Internet.

2. Current AP Telecommunications Infrastructure

Evidently telecommunications play a vital role in infrastructure development and economical growth. However, under-investment in telecommunications facilities is common in many of less developed countries. Reasons contributed to this phenomenon include lack of resources, multiple languages, geographical diversity, inadequate manpower and skills, and cultural differences. For the developed countries, they have fairly advance domestic networking infrastructure with T-1 or FT-1 international links. Meanwhile, in some developing countries, networking activities are negligible or e-mail is not available yet.[1]

Currently, regional connectivity in Asia Pacific is accomplished primarily through an international leased line into the US infrastructure. There are several reasons for this: 1) Intercontinental leased lines cost marginally more than intracontinental leased lines. 2) All countries primarily communicate with USA. 3) One fat pipe makes more sense than multiple thin pipes.[2]

905

Meanwhile, most AP countries adopt TCP/IP (Transmission Control Protocol/Internet Protocol) as a standard protocol for their networking systems. Few countries such as China attempt to use OSI (Open Systems Interconnect) model as the standard protocol, however, it turns out to be quite disappointing. With the proliferation of UNIX systems and the influence of U.S.A., TCP/IP is now regarded as the most common protocol for internetworking.

3. Internet Development in the Asia Pacific Region

Like other parts of the world, Asia Pacific Internet is also experiencing an unprecedented exponential growth. According to the latest Internet host survey released by Mark Lottor of Network Wizzards in February 1995, the rate with which new systems are connected to the Internet for 4th Quarter 1994 is 19% in Asia and 25% in Pacific.[3]

Regional Growth - 1994

	Oct. 94	Jan. 95	4Q94
North America	2,685,929	3,372,551	26%
CC&S America	14,894	*	*
Europe, West	850,993	1,039,192	22%
Europe, East	32,951	46,125	40%
Middle East	10,383	13,776	33%
Africa	21,041	27,130	29%
Asia	**127,569**	**151,773**	**19%**
Pacific	**154,473**	**192,390**	**25%**
Total	3,898,233	4,851,873	24%

* Accurate Latin America host counts are not obtained.
[Src: http://www.nw.com/zone/WWW/isoc-pr-9501.txt]

A more detail observation is available on per country basis.

Host Growth in Selected Asia Pacific Countries

Country	Jan. 95 Hosts	4Q94	1994
Australia	161,166	20%	50%
Japan	96,632	17%	86%
Korea	18,049	24%	101%
Taiwan	14,618	25%	83%
Hong Kong	12,437	18%	52%

[Src: http://www.nw.com/zone/WWW/isoc-pr-9501.txt]

4. Internet Case Studies

In order to better understand the development of the Internet in the Asia Pacific region, it is necessary to examine from a country to country basis.

4.1 CHINA:

At present, China's major wide area network (WAN) is the China National Public Data Network (CNPAC). It is an X.25 packet switched network connecting to 688 provincial capitals and 60,000 terminals.[4] CNPAC carries data at speeds varying between 1.2 and 9.6 Kbps and its international link runs at 64 Kbps backbone rate.[5]

The Chinese Research Network (CRN) was founded in 1987. It aims at providing electronic communications based on the PSDN and any other available communications networks, to the Chinese research community. Unlike other countries in the AP region, CRN supports and coordinates the development of OSI protocol. Tens of direct message handling system (MHS) connections are established by CRN with the member countries of European Reasearch Networks (RARE), including Germany, Norway, Switzerland, France, Sweden, Italy, England and Netherlands. In addition, CRN provides a CCITT X.400 e-mail service to its users. The e-mail exchange between CRN and other e-mail systems, e.g. Internet, Bitnet, UUCP, is routed by RARE gateways.[6]

Another noteworthy networking system in China is the Tsinghua University Network (TUnet). Its campus network, along with Beijing Universities and a number of research institutes of the Chinese Academy of Sciences (CAS), is connected by the National Computing and Networking Facility of China (NCFC) as a two level system. The top level of NCFC consists of the backbone and the network control center. Meanwhile, the second level consists of campus networks at the universities. Currently NCFC runs a 10Mbps backbone connecting the three campus networks, which will increase to 100Mbps in the near future.[7]

TUnet aims to be a multimedia integrated services network providing not only data but also voice and video. It will operate initially under TCP/IP protocol, however, it will eventually operate according to the ISO/OSI standard. Currently TUnet has three major facilities: 1) A circuit switched network based upon an integrated services PABX. 2) A packet switching network based upon X.25 switches and PADs. 3) Ethernet LANs interconnected through a 100Mbps FDDI optical fiber backbone.[8]

It is not, however, until May 1995 did China offer commercial Internet Service (ChinaNet). ChinaNet is a nation-wide Internet supported by the NCFC backbone. A 64 Kbps dedicated link connects the ChinaNet, via Sprint International's router, to The NSFNET (National Science Foundation Network) which is the main body of The Internet.[9]

4.2 AUSTRALIA:

The Australian Academic and Research Network (AARNet) is a member network of the Internet that uses the Internet protocol (TCP/IP). AARNet is owned and operated by the Australian Vice-Chancellors' Committee (AVCC) as a service to the participating member institutions of the AVCC and the Commonwealth Scientific and Industrial Research Organization (CSIRO).[10] AARNet itself does not provide services to end-users. Instead, it enables users of systems that are connected to AARNet to access resources and services made available by other entities connected to the network. As the result, there's no AARNet "userID". Access to AARNet can be obtained from communications link between the computing facility and an AARNet network gateway.[11]

Currently Australia's Internet bandwidth ranges from around (192Kbps and 256Kbps) for medium speed to high speed (2Mbps and 10Mbps) leased lines that link multiprotocol routers. Terminating the leased line is a gateway server or a router that must be interoperable with the AARNet Cisco Systems router used at all regional hubs.

SLIP/PPP links are also made available by the AARNet to support low speed, low cost asynchronous links. These links usually use a 9.6Kbps leased lines or dial-up service utilizing the Serial Line IP Protocol (SLIP) or Point-To-Point Protocol (PPP). Generally, SLIP connections are appropriate when the number of systems to be connected is small, the volume and quality of service required by the affiliate member are not high, and/or the budget is severely constrained.[12]

4.3 TAIWAN:

The Taiwan Academic Network (TANet) is supported by the Ministry of Education and University Computer Centers to establish a common national academic network infrastructure. TANet is a two-layer hierarchy. The national backbone network and management of international links are supported by the TANet network service center (TANSC). Within each regional area, a regional network service center (RNSC) is responsible for the connections from the local area network and/or campus of each university to the interface of the TANet backbone.[13]

In terms of protocols used, the TANet backbone will initially focus on the TCP/IP protocol. Support for OSI protocol will be introduced in the near future. Regional networks may support multi-protocols and additional facilities such as X.25 transport or dial-up services on a local basis.[14]

An international link bandwidth has upgraded from 64Kbps to 256Kbps between the Ministry of Education (MOE) Computer Center and Princeton University (JvNCnet) in November of 1992. This link couples TANet with JvNCnet, NFSNET and the international Internet connection.[15]

4.4 JAPAN:

The Widely Integrated distributed Environment (WIDE) Internet is a non-government network with funding support from about 25 private companies. It has total of six Network Operating Centers (NOCs) located in Tokyo, Fujisawa, Kyoto, Osaka, Fukuoka and Sendai.[16]

The WIDE Internet is composed of a variety of links including voice grade leased lines, 64Kbps and 192 Kbps digital leased lines, and ISDN. The above six NOCs are connected to universities and private companies through 64 Kbps to 192 Kbps leased lines. The WIDE Internet supports TCP/IP as the basic protocol. TCP/IP over X.25 is used in some ISDN links with the line speed of 64 Kbps or 128 Kpbs.[17]

Internationally, the WIDE Internet operates in conjunction with the Pacific Area Computer Communication (PACCOM) project to provide international links for Japanese researchers using 192 Kbps under-sea cable via University of Hawaii to NASA Ames, FIX-WEST.[18]

5. Global Internet Exchange

As demonstrated from above case studies, the capacity of each country's networks varied quite significantly. This, in turn, increases the complexity of The Internet both logically and physically as the number of these different networks connecting to The Internet also increases. A more comprehensive routing scheme is required to ensure internetworking stability. Consequently, Global Internet Exchange (GIX) is proposed to be the model for internetworking because it receives wide support from both the European and U.S. networking communities. Logically, AP GIX is recommended to be located at the west coast of U.S. or in the Pacific.

The physical GIX is a "layer-2" type infrastructure that aims to provide maximal flexibility and maximal connectivity for the exchange of routing information and packet payload between different network service providers. Here, maximal flexibility means that any organization connecting to the GIX has the power to implement their own routing policy independent of the other partners connecting to the GIX. Meanwhile, maximal connectivity means if a provider connects to the GIX, that provider has the possibility to forward traffic to the global Internet.[19]

5.1 In order to gain maximal connectivity, an accountable neutral routing registry (RR) is needed. Different IP network providers register their preferred path for routing from the GIX with the RR. RR provides administrative control for all routing updates. This is accomplished by adopting a common policy specification language to express routing policies, and have these policies store and maintained in a common policy routing database.[20]

It is proposed that there should be three RRs, one per geographical region: Asia-Pacific, North America and Europe.[21] Specifically within in the AP region, the Asia Pacific Network Information Center (APNIC) is set up under the authority of Asia Pacific Coordinating Committee for International Research Networks (APCCIRN) to provide Routing Registry service. Routing in the AP region is not nearly as complex as that faced by the European networking community. Currently RR is still under development by the APNIC.[22]

5.2 Another key function recommended by the GIX model that needs to be provided to the AP networking community is the Route Server (RS). Route Server is used to provide the general routing information needed to implement a scaleable global Internet infrastructure. It is a pseudo-router running on a host directly connected to the physical GIX. There will be at least one RS for every RR. The RS implements external routing protocols and maintains a routing table for destinations served by the RR operating the RS.[23]

It is suggested that there should be at least one or more regional AP Route Servers at the GIX with which anyone connected to the GIX may peer with and consequently get a consistent and controlled view of the routing. Both Europe and US have their own regional RS. An Asia-Pacific RS is yet to be deployed.[24]

5.3 On the other hand, the APNIC has made tremendous progress in terms of Internet Registry services. Internet Registry functions consist mainly of IP address allocation management and WHOIS database administration. On April 1, 1994, the APNIC received delegation of the 202.x.x.x and 203.x.x.x Class C address blocks from the Internet Assigned Numbers Authority (IANA).[25]

Furthermore, the implementation and support for class B application processing is suggested to be provided by regional and national NICs. This enables distribution of the workload among the various NICs. As the result, the initial processing of requests can be done at the level closest to the applicant that will allow greater coordination with the applicant. Applications for a class B network are forwarded to the InterNIC for processing under the guidelines of RFC 1466.[26]

In regards to Class C network allocation policy, the APNIC has implemented a loosely defined "super-block" allocation scheme. Its goal is to provide a flexible framework for allocations of the class C address space set aside for the AP region on a country by country basis. It is hoped that an adjustable amount of address space can be allocated to a country as needed. Aside from the 202.x.x.x and 203.x.x.x address blocks already assigned, each country attempts to make a best estimate of future address usage, and as the result a rough idea of the "super-block boundaries" was formed. New allocations to a specific country are made from one end of the super-block" for that country and expand toward the next "super-block". This scheme will allow the "super-blocks" to flexibly grow to a right size through further IP address allocations.[27]

6. Challenges and recommendations to Implementation

Successful deployment of the Internet in the Asia Pacific region faces serious challenges due to the distinctly different development models of the AP member states. The real challenge is not technical or financial, but organizational, political and cultural. Although each country's technical, human capability, and regulatory limitations to network development vary dramatically and thus demand a unique response, it is, however, beyond the scope of this paper. Rather, this paper will provide high level recommendations which aim to promote successful implementation of the internet in a broad networking environment.

6.1 Technically, less developed countries within the AP region can seize the opportunities to implement today's advance telecommunications technologies which will allow them to leapfrog into the future. Financially, funding can be obtained from organizations such as World Bank or from private sector that has interests in long term investment in telecommunications products and services.

6.2 Politically, many countries in the Asia Pacific region have strict telecommunication regulations designed to protect the monopoly of telecommunication industries. The Internet and information networks are in turn affected by these regulations which result in high communication costs, low-quality services and limited development. To overcome this downfall, a more competitive market environment in telecommunications and other information related industries are strongly encouraged. This can be accomplished by allowing more private sector participations at the national level. The associated benefits brought by enhanced competition include substantial price falls, a wider range of products and services, improved carrier performance and a greater emphasis on quality and customer service.

6.3 Culturally, the success of the Internet will rely significantly on the promotion of local content. Consequently, it is important to promote linguistic diversity since many countries in Asia use quite different languages from English such as large character sets. A network that offers only English will inevitably limit its usage and consequently ends up as a user-unfriendly system. Therefore, national NICs or local networking coordination centers should promote local language support as one of top priorities.

6.4 Other significant factors critical in contributing to the success of the Internet in the Asia Pacific region include:

6.4.1 Universal Service: At present, provision of universal service may be a difficult goal to attain particularly for less developed countries in the Asia Pacific region where they may have more pressing basic needs and priorities. Nevertheless, in order to ensure that everyone have access to new information services and thus benefit from new opportunities, an adaptable and an affordable universal service framework should be established.

6.4.2 Information Security: Asia-Pacific networking authorities should work collectively to increase the reliability and security of national and international networks. Rapid development and deployment of security techniques such as encryption and authentication will be critical for the Internet. Without these technologies, the Internet cannot reach its full potential in permitting the authenticated and confidential transfer of sensitive data.

6.4.3 Training: Training represents one of the most essential component of network development. To ensure wide acceptance of the Internet, end users have to be comfortable with the technology and knowledgeable in the basics of using applications like e-mail and remote data access. Training is also important in designing and managing the physical attributes of the Internet.

[1] Chon, Kilnam, "Internetworking in Asia", rs.krnic.net:70/00/ftp/apng/044.chon.connexions, May 1994.

[2] ibid.

[3] Internet Society, "Latest Internet Host Survey Available: The Internet Is Growing Faster Than Ever", www.nw com/zone/WWW/isoc-pr-9501.txt, February 1995.

[4] "Internet to Officially Open to Public in April", BBC Summary of World Broadcasts, March 29, 1995.

[5] "X.25 in China", http://solar.rtd.utk.edu/~china/network/X25.html.

[6] Zhao, Xiaofan, "Introduction on CRN", rs.krnic.net:70/00/0R0-6169/ftp/apng/net.description/crn.net.description, September 1992

[7] Kuo, Franklin F., "Networking In The People's Republic of China (PRC)", rs.krnic.net:70/00ftp/apng/net.description/china.net.description, July 1992

[8] ibid.

[9] "ChinaNet-China Internet Home Page", http://www.cnc.ac.cn/

[10] Tsang, Philip, "Internet Growth in Australia and Asia's Four Dragons", www.ncsa.uiuc.edu/SDG/IT94/Proceedings/Int/tsang/tsang.html, 1994

[11] "Connecting to AARNet", info.aarnet.edu.au/aarnet/documents/affiliate.html, June 1994

[12] ibid.

[13] Chen, Wen-Sung, "TANet, The Taiwan Academic Network", rs.krnic.net:70/00/ftp/apng/net.description/tanet.net.description, June 1993

[14] ibid.

[15] Tsan, Philip, "Internet Growth in Australia and Asia's Four Dragons"

[16] Ishida, Haruhisa, "Academic Internetworking In Japan", rs.krnic.net:70/0R0-28005/ftp/apng/net description/japan.net.description, July 1992

[17] Murai, Jun, "Japan-WIDE", jun@wide.sfc.keio.ac.jp

[18] ibid.

[19] Eidnes, Harvard, "Distributed GIX Specification", info.aarnet.edu.au/iepg/docs/D-GIX-proposal.html

[20] ibid.

[21] Bates Tony, Karrenberg Daniel, Lothberg Peter, Stockman Bernhard and Terpstra Marten, "Internet Routing In A Multi-provider, Multi-path Open Environment", rs.krnic.net:70/00/ftp/apng/012.internet.routing.txt, August 1993

[22] Conrad, David R., "New Asia-Pacific Network Information Center (NIC) Initiated", rs.krnic.net:70/00/ftp/apng/040.APNIC.txt

[23] Bates, Tony, etc. page 1

[24] Eidnes, Harvard, page 2

[25] Gebes, Vincent J., "Asia Pacific Network Information Center Pilot Project Final Report", apnic.net:/apnic/docs/english/apnic-007.txt, December 1993, page 3

[26] ibid. page 5

[27] ibid. page 6

BIBLIOGRAPHY

Almes Guy, Ford Peter, and Lothberg Peter. "Proposal for Global Internet Connectivity-IEPG Working Document", rs.krnic.net.70/00/ftp/apng/015.gix.proposal.iepg

APNG Secretariat, "APNG Database on International Links", rs.krnic.net:70/00/ftp/apng/007.link.db, August 1994

Bates Tony, Daniel Karrenberg, Peter Lothberg, Bernhard Stockman and Marten Terpstra, "Internet Routing in a Multi Provider, multi path Open Environment", rs.krnic.net:70/00/ftp/apng/012.internet.routing.txt

Chen, Wen-Sung, "TANet, The Taiwan Academic Network", rs.krnic.net:70/00/ftp/apng/net.description/tanet.net.description, June 1993

"ChinaNet-China Internet Home Page", http://www.cnc.ac.cn/

Chon, Kilnam, "Internetworking in Asia", Korea Advanced Institute of Science and Technology, rs.krnic.net:70/00/ftp/apng/044.chon.connexions, May 1994

"Connecting to AARNet", info.aarnet.edu.au/aarnet/documents/affiliate.html, June 1994

Conrad, David R., "New Asia-Pacific Network Information Center (NIC) Initiated", rs.krnic.net:70/00/ftp/apng/040.APNIC.txt

Eidnes, Havard, "Distributed GIX Specification", info.aarnet.edu.au/iepg/docs/D-GIX-proposal.html, November 1993

Gebes, Vicent J., "Asia Pacific Network Information Center: Pilot Project Final Report", apnic.net:/apnic/docs/english/apnic-007.txt, December 1993

Ishida, Haruhisa, "Academic Internetworking in Japan", rs.krnic.net:70/0R0-28005/ftp/apng/net.description/japan.net.description, June 1992

"Internet to Officially Open to Public in April", BBC Summary of World Broadcasts, March 29,1995.

Internet Society, "Latest Internet Host Survey Available: The Internet is Growing Faster Than Ever", http://www.nw.com/zone/WWW.isoc-pr-9501.txt

Kuo, Franklin F., "Networking in the People's Republic of China (PRC)", rs.krnic.net:70/00/ftp/apng/net.description/china.net.description, July 1992

Murai, Jun, "Japan (WIDE)", jun@wide.sfc.keio.ac.jp

Park, Taeha, "Proposal for Distributed APNIC Operations", apnic.net:/apnic/docs/english/apnic-007.txt

Tsang, Philip, "Internet Growth in Australia and Asia's Four Dragons", www.ncsa.uiuc.edu/SDG/IT94/Proceedngs/Int/tsang/tsang.html

"X.25 in China", http://solar.rtd.utk.edu/~china/networks/X25.html.

Zhao, Xiaofan, "Introduction on CRN", rs.krnig.net:70/0R0-6169/ftp/apng/net.description/crn.net.description, September 1992

Multipoint Videoconference System

Junichi Iizawa*, Yukari Kamura*, Teruo Katsumi*
Makoto Miyazaki*, Kazuhiro Kawamoto**, Isao Masuda*
*NEC Corporation, **NEC Engineering Inc.
Tokyo, Japan

Abstract

This paper discusses the configuration and major function of NEC's multipoint videoconference system consisting of several video CODECs and a MCU (Multipoint Control Unit). It conforms to the ITU-T standards for videophone and teleconference (Rec. H. 221, H. 230, H. 242, H. 261 and H. 320), and the ITU-T standards for multipoint videoconference (Rec. H. 231 and H. 243), respectively.

1. INTRODUCTION

Along with the recent propagation of ISDN services and decreasing price of a video CODEC, together with the trend of many companies wishing to save travel expenses and time, the introduction of videoconference systems has been rapidly increasing. In addition, since recent personal computers are coming to have higher performance, more customers are introducing such personal computers as their desktop video CODECs.

As the users tend to pay attention to these "multimedia", they strongly hope that videoconference systems will become capable of providing multipoint or multi-dimensional services. In addition, the demand for interconnectivity between already installed videoconference systems as well as desk-top video CODECs made by various manufacturers is increasing.

In order to hold a multipoint videoconference by connecting multiple video CODECs, a specific device called the Multipoint Control Unit (MCU) is being used. By connecting video CODECs to the MCU at the center in the shape of a star, the MCU performs the distribution and control of video images as well as audio signals.

The MCU internally separates video, audio and control data sent from the respective video CODECs. For video images, it selects a single station among the terminals at the participating sites and transmits them to each terminal (for example, a video image of the speaker is broadcasted). For audio signals, it mixes voice signals sent from each terminal and transmits them to all participating terminals. Control data are used to control a multipoint conference from a terminal and to implement the following functions:

- Notifying the number of participating terminals
- Notifying the names of participating sites
- Broadcasting local video images
- Acquiring the "Chair-control" privilege for selecting a video image to be transmitted
- Selecting a participating site separately
- Controlling (such as zooming and focusing) a camera installed at the other party

Although the MCUs have already been commercialized by several manufacturers, most of them only accept terminals made by the same manufacturer to configure a videoconference system, and manage a conference session by switching a single screen image. And though the term "multipoint conference" suggests to many users a multi-screen display using a screen composition technique, there are only a few MCUs on the market which have this type of multi-screen display function. Therefore, many users demand this multi-screen display function at a low price, interconnectivity using terminals for video conferences made by different manufacturers as well as the use of desk-top video CODECs.

Regarding the video CODEC, the ITU-T standards (including H. 221, H. 230, H. 242, H. 261 and H. 320) have already been published as recommendations. In 1993, additional ITU-T standards for multipoint videoconference equipment (including H. 230, H. 231 and H. 243) were established.

NEC has developed a multipoint control unit

912

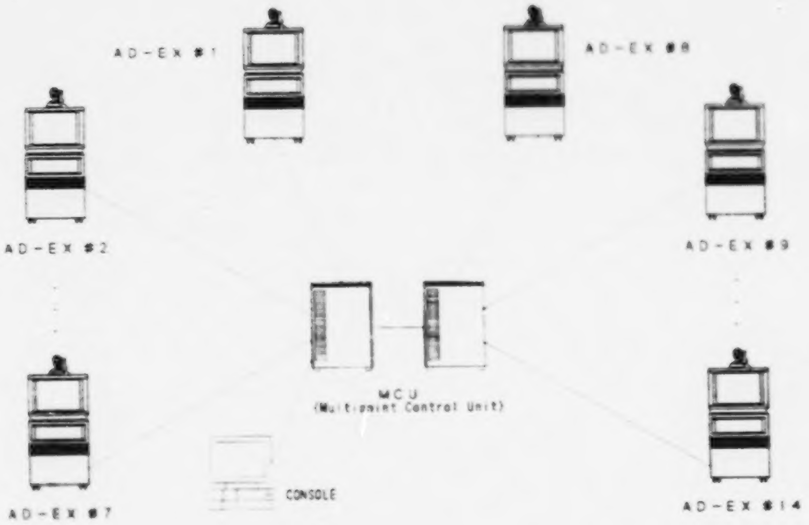


Fig. 1 MULTIPOINT VIDEOCONFERENCE SYSTEM CONFIGURATION

3. SYSTEM FUNCTIONS (ITU-T MODE)

The following describes the functions of this system. While operating the MCU under the ITU-T mode (using a BAS for the control between the MCU and video terminals), all of the terminal-control tasks are carried out through the standardized procedures.

Therefore, any terminals made by other manufacturers which conform to the standards (H. 320, H. 243, etc.) can also be connected.

This operation mode, conforming to the standards, is called the "ITU-T mode", while "Proprietary mode" stands for the operation mode developed for the extended function using an NEC original sequence.

3.1 OPENING A VIDEO CONFERENCE

A video conference is opened by issuing the videoconference open command to the MCU. In most cases, a video conference is performed after connecting a control terminal (both a simple operation terminal and a reservation system are provided) to the control console port of the MCU and through an operation from a user.

The following types of video conferences are available:

- Point-to-point conference
- Broadcasting
- Multipoint conference (ITU-T mode)
- Multipoint conference (proprietary mode)

One of the above-listed conference types can be selected through control from the console.

When using an ISDN line, a line connection is established by calling the MCU from a terminal using remote control, or by calling the respective terminals from the MCU via the control terminal. For lines linked by cascade connections, a connection is made by calling from one of the linked MCUs.

The MCU has a function to automatically perform a sequence of commands needed when making a connection. Therefore, by memorizing such commands which must be executed, a video conference can be opened automatically simply by turning ON the power.

3.2 TERMINAL PARTICIPATION TO A VIDEOCONFERENCE SYSTEM

A video terminal can be joined in a videoconference session after setting the opening of a multipoint videoconference session using the MCU and by connecting the MCU and the video terminal through a leased line or an ISDN line. The number of terminals which can participate in a videoconference session may vary with the system configuration. For example, up to 20 terminals can take part in a conference session when connecting three MCUs linked by cascade connections. Any terminal can participate or withdraw at any time during a conference session.

3.3 AUDIO SIGNAL CONTROL

Upon receiving audio signals from a terminal participating in a videoconference session, they undergo "add" processing; such added audio signals are distributed to all other terminals. Therefore, each terminal always receives audio signals from the other terminals, except for those from itself, which are "add-processed" by the MCU.

For audio signals, either standard-quality signals (according to G. 711 μ-law PCM or G. 728 LD-CELP at 3.4 kHz) or high-quality signals (according to G. 722 SB-ADPCM at 7 kHz) can be selected. While using the high-quality mode, if a video terminal does not have such capabilities, other terminals can automatically be set back to the standard-quality mode by the performance-switching procedure.

3.4 VIDEO SWITCHING MODES

Video data to be distributed to each video CODEC can be switched under control of the respective terminals. The VisuaLinks AD-EX Series terminal can switch a video image by using a remote controller. The following outlines this screen-switching control:

(1) VOICE-ACTIVATION

When the speaker changes, the video image can automatically be switched so that the new speaker is viewed.

Under this mode, the audio-signal levels received from the respective terminals are periodically compared among them. If a video terminal is judged to be that of a new speaker, according to the signal level, the main speaker is searched in the video image from that terminal. Then, the video image from that terminal is distributed to all other terminals. In this case, the terminal for that speaker keeps receiving the same video image which it had been receiving so far.

This automatic switching is the default control operation, while no other video-switching control is performed from any other terminal.

(2) TRANSMISSION REQUEST

When a terminal requests to transmit its video image, that image is broadcast to all the other terminals.

(3) CHAIR-CONTROL CONTROL

The operator of the chair-control terminal selects and switches the broadcast video during the conference.

(4) RECEIVING SELECTION

Each terminal individually determines the video terminal from which it will receive. Note that if a target terminal is not connected to the same MCU as that of the local terminal (or a target terminal is the one that is connected to another MCU linked by a cascade connection), the video image from the target terminal cannot be received.

3.5 CHAIR-CONTROL TERMINAL

A terminal having the capability to steer the proceedings (which has been regulated by the ITU-T standard H. 243) can request an "Chair-control" privilege to the MCU. By acquiring the "Chair-control" privilege, that terminal can perform the following control privileges:

1) Broadcasting a video image from an arbitrary terminal
2) Displaying a speech request from a terminal

3.6 EXTENDED FUNCTIONS

While using the VisuaLinks AD-EX Series, the following functions are available:

(1) SITE NAME DISTRIBUTION

By distributing information regarding each site participating in a videoconference session, the site name can be displayed on the screen (Japanese characters can be displayed).

(2) CONFERENCE STATUS DISPLAY

Each terminal can turn ON or OFF the screen display (regarding the name of the receiving station, "send" status as well as the number of participating sites).

(MCU5000A and QV-MUX) which can handle video CODECs (VisuaLinks AD-EX Series) and desk-top video CODECs that conform to the above-mentioned recommendations. The following is an outline of the new equipment.

2. SYSTEM CONFIGURATION

This system comprises the main Multipoint Videoconference Control Unit (abbreviated "MCU") of "NEC MCU5000A", as well as multiple video CODECs, such as "NEC VisuaLinks AD-EX Series" or those terminals made by other manufacturers.

It can handle any video CODECs made by other manufacturers which conform to the ITU-T H. 320 recommendations (except for NEC's proprietary functions, which are available only for video CODECs of the VisuaLinks AD-EX Series; refer to a later part of this paper for details).

2.1 VIDEO CODEC

NEC has commercialized the VisuaLinks AD-EX Series Videoconferencing Equipment used as a terminal for a multipoint videoconference system. This system comprises the main videoconference control equipment (TC5000EX), which incorporates a video coder in a single housing, together with other peripheral units, such as a monitor, a camera and microphones. Various types are provided, including a "desk-side" type, an "all-in-one" type which packages all units in a single rack, and a "twin" type which has two units comprising monitors, cameras and racks; the customers can easily configure a videoconference system according to their usage and applications. Photo 1 gives an external view of this terminal.

2.2 MULTIPOINT CONTROL UNIT (MCU)

NEC has commercialized both the MCU5000A and the QV-MUX as its Multipoint Control Unit (MCU). A single MCU5000A can accommodate all terminals installed in 8 separate locations in a single videoconference session, or in 14 locations (with two MCUs linked via cascade connections), or in 20 locations (with three MCUs linked via the same connections). Photo 2 shows the external appearance of the MCU5000A.

A single QV-MUX can link terminals at 4 different locations for a single video conference. With its screen composite function, it can display images from 4 locations at the same time. Photo 3 shows the external appearance of the QV-MUX.

For a multipoint videoconference using three or more terminals, a single MCU can simultaneously establish a videoconference among up to two groups (while only one group can participate with the QV-MUX). In addition to a multipoint conference, a point-to-point conference or broadcast-type connections can also be carried out at the same time. In the case of a video conference involving a large number of users, a broadcast-type conference (with one-way communication) connecting several tens of locations can be established by connecting several MCUs.

While performing a multipoint videoconference, audio signals are multiplexed and distributed to the respective locations. A video image sent from a single location is distributed to terminals at other locations. As described later, a video image can be switched by the automatic switching function according to a change of audio signals or by manual switching directed by a remote controller connected to each terminal.

2.3 CONNECTIONS

Fig. 1 shows a schematic figure of a system configuration. Multiple video CODECs are connected in the shape of a star to the MCU, which is in the center. This MCU can be linked to another MCU via a cascade connection in order to increase the number of terminals which can be connected.

Both ISDN (NTT PRI/BRI or AT&T PRI) lines and high-speed digital leased lines (at 64 kbit/s to 1,920 kbit/s) can be used as connection lines to this system. By using an interface converter (such as a TA), satellite circuits as well as overseas ISDN lines can also be connected.

An in-band control port is used for control from a terminal to the MCU. While operating under the control according to the ITU-T standards, a Bit-rate Allocation Signal (BAS) is used. On the other hand, a data port can also be used to control NEC's proprietary extended functions. When controlling a multipoint videoconference session, the system provides both the ITU-T mode using only a BAS and the Proprietary mode through only a data port. In order to connect any terminals made by other manufacturers, both the MCU and all video CODECs must be operated under the ITU-T mode.

(3) LIST DISPLAY OF ALL PARTICIPATING SITES

Usually, both the site number and the site name are displayed. By operating a remote controller, the numbers and names of all participating sites can be listed.

(4) AUDIO-SIGNAL DETECTION SETTING

From an arbitrary terminal, the audio-signal detection function of the local station can be either enabled or disabled. When this audio-signal detection function is disabled, automatic video-image switching using the audio level (described above) is canceled.

4. SYSTEM FUNCTION (PROPRIETARY MODE)

While operating the MCU under the proprietary mode, the various extended functions described below as well as those available under the ITU-T mode can be used. Since this mode uses a data port, it features a high-speed control operation compared to that for the ITU-T mode using a BAS.

Note, however, that when connecting terminals made by other manufacturers while in the proprietary mode, the following functions, except for the automatic video-image switching, are not available for those terminals.
The following explains the functions provided under the Proprietary mode. Table 1 gives a list of the system functions.

4.1 TRANSMISSION CONTROL FOR COMPOSITE SCREEN IMAGE

When using the QV-MUX as the MCU, a composite screen image can be broadcasted by using a remote controller from Chair-control terminal. Each participating site can specify the transmission of a composite screen image to the receive-selected site.

A composite screen image from 4 different sites can also be transmitted to all other sites, though this image is not interchangeable (in this case, automatic video-image switching using the speaker detection function is not carried out).

4.2 EXTERNAL CONSOLE CONTROL

With control from an externally connected console, such operations as assignment of the Chair-control

Table 1 LIST OF SYSTEM FUNCTIONS

ITU-T Mode	*Proprietary Mode*
Voice activation *	Voice activation *
Transmission request *	Transmission request
Assignment and release of Chair-control token *	Assignment and release of Chair-control token
Broadcast by the Chair-control terminal *	Broadcast by the Chair-control terminal
Receive selection *	Receive selection
Request for speech *	Request for speech
Indication of the site name	Indication of the site name
Still-picture transmission from an arbitrary site	Still-picture transmission from an arbitrary site
Switching using the audio-signal detection	Switching using the audio-signal detection
	Switching of a monitored terminal of the broadcaster
	Control for composite screen images **
	External console control
	Controlling of a video camera installed at the other party
	Pointer control
	Use of an electronic "black board"
	Message display
	Connection of analog telephones
	Speech approval

*: Indicates the functions available with any video terminal made by other manufacturers.
**: Available only with the QV-MUX.

privilege, broadcasting transmission and receive selection can be performed. In addition, a monitoring target at the broadcasting source can be switched, which cannot be carried out using the remote controller of a terminal.

4.3 CAMERA OPERATION CONTROL TO THE OTHER PARTY

By using a remote controller of the local terminal, such camera operations as zooming, focusing and position adjusting for the camera presently being used to monitor a specific location can be performed. Also, if multiple cameras are used by the other party, such cameras can be switched between each other by this operation.

4.4 POINTER INDICATION

A pointer is used as an arrow-type pointing marker to indicate the same position on each terminal screen when using conference materials, such as documents and drawings. The pointer can be controlled only by the Chair-control and is moved upward, downward, and to the left and right by a remote controller connected to the Chair-control terminal. The pointer displayed on each terminal is moved in the same manner as the Chair-control moves the pointer on the local screen.

4.5 ELECTRONIC "BLACK BOARD"

Any hand-written characters and figures drawn on an electronic "black board" or a desk-top tablet connected to each terminal can be displayed on the screen of each terminal on a real-time basis. Pointing to a figure as well as erasing any part or all parts are possible. Also, an image of the displayed screen can be printed out.

4.6 ON-SCREEN MESSAGES

With control from an external console connected to the MCU, a message can be displayed on a terminal in an arbitrary location. Kanji and Kana characters as well as alphanumeric letters can be used in a message. In addition, the MCU can broadcast a message tone to all terminals of the participants.

4.7 PARTICIPATION USING ANALOG TELEPHONES

An analog telephone can be used as a terminal of a multipoint videoconference session. In this case, a video image is not automatically switched against a speech through an analog telephone.

5. CONCLUSION

A multipoint video conference system has been outlined above. An image network typically using a multipoint videoconference system is expected to become widespread, not only for videoconferences, but also for applications to education and monitoring systems. We will continue to make our best effort to develop an easy-to-use small-size system at a low price.

REFERENCES

(1) "MCU Multipoint Video Conference Control Unit", Onaka, et al, NEC Technical Report, Vol. 44, No. 6, pp. 32 to 38, 1991-8.
(2) "MCU Multipoint Video Conference Control Unit", Iizawa, et al, Fall meeting of the Electronic Information Communication of Japan, September 1992, D-190.

Photo 1 EXTERNAL VIEW OF THE VISUALINKS AD-EX

Photo 3 EXTERNAL VIEW OF THE QV-MUX

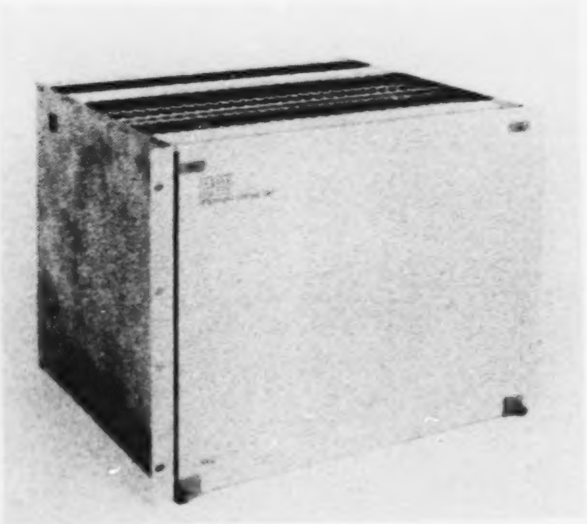


Photo 2 EXTERNAL VIEW OF THE MCU5000A

A PROPOSED "OPEN STANDARDS" TECHNIQUE FOR PROVIDING INTERCONNECTIVITY BETWEEN THE NATIONAL COMMUNICATION SATELLITES AND THE GLOBAL BROADBAND SATELLITE NETWORKS

John F. Purchase
President, InterSys L.L.C.
Tempe, Arizona

1. ABSTRACT

Now the imminent reality of a global "Information Superhighway," — or "Infobahn," as it is perhaps more often known — is readily accepted, it is perhaps time to consider how the many and various national and regional communication satellite system operators can connect their own systems into the currently proposed global Ka-band satellite networks. For, right now, there is no obvious "on ramp" for these frequently politically important groups. The solution to this user and market dilemma is for the network system operators and the satellite system suppliers to agree on a set of "open system standards" for the interface design and performance of the communications links of the satellites to be used for the Infobahn. In this way any national or regional satellite system operator would be able to procure communication satellites for connection into the Infobahn from any competitive satellite supplier, and provide purely regional or national Infobahn connection services to their own client base. The working example for such an Infobahn solution already exists in the Internet. This informal worldwide network of computers was conceived and designed in North America but was implemented worldwide as the *open distribution* of a series of *interface standards* for protocols — TCP/IP, for example. *That is, it is an open system architecture.* Thus, any computer system operator anywhere in the world could connect their computer system into the net and participate as a full partner as long as they adhered to the published standards. In a previous *Via Satellite* article[1] the author argued a similar "open system standards" architecture for the new broadband satellite networks was entirely feasible and very marketable. This paper now goes the next step and defines the interface architecture and standards for a satellite-based broadband network using currently accepted and suitable "open system standards" for the critical common-user interfaces. The objective is to provide a "plug in" satellite capability which will allow any satellite system operator to procure satellites and connect them into the global networks. Sufficient data is provided to justify the standards selected and to demonstrate the system performance to be obtained. The result is a realistic and pragmatic development path for a truly Global information infrastructure.

2. SYSTEM CONCEPT

Today, virtually all communications traffic — video, voice, data — has converted to the digital format, with the little remaining analog form undoubtedly converting within a few years at most. As a consequence, the satellite designers have been freed from the restrictions imposed by the analog form and are now producing broadband regenerative communications payloads in place of the traditional fixed narrow bandwidth, bent-pipe designs. These payloads include a sophisticated all-digital Baseband Processor (BBP) which demodulates and decodes the uplinked packetized traffic, and then routes the traffic data packets to the appropriate downlink or crosslink beam according to the packet header addresses or to signalling channel commands for recoding, remodulating and onward transmission. This effectively places the network traffic switch in the satellite instead of at the ground station, greatly increasing the overall system efficiency — an approach pioneered and demonstrated by the NASA ACTS research program and now being commercially implemented by IRIDIUM and proposed by Teledesic, CyberStar, Astrolink, GE*Star, Millennium, NetSat 28, VoiceSpan, KaSTAR and Spaceway for Ka-band satellite-based networks. The key aspects are:

- the traffic is all digital;
- traffic channel bandwidth is variable and is allocated on-demand;
- packet communications standards are used for the traffic;
- the traffic routing is performed on board the satellite by a digital switch / router;
- the satellites are interconnected by microwave crosslinks — Intersatellite Links (ISL's) — to form a network of interconnected "nodes."

These networks are expected to carry a whole multitude of different traffic types:

- cellular and personal communication network (PCN) phone traffic
- PSTN traffic
- video conferencing
- television
- computer networking
- aeronautical communications
- fiber optic networks
- etc.

The problem is how to define the system architecture and satellite system interfaces to achieve a "plug in" capability for any single satellite. Figure 1 shows in functional block diagram form, a single satellite connected into both a space–based network and a ground–based network — the importance of the latter will become evident in the subsequent discussions of communication protocols. As the figure shows, the important interfaces and parameters (underlined in the Figure) are:

- the Communications Traffic Links — the protocols and the FDM / TDM / CDM access schemes; and possibly the frequencies and modulations as well if "cross border operability" of the user's ground terminal equipment is desired.
- the Ground Network RF Connection Links — the protocols and access schemes, and possibly frequencies and modulations; these will be the same as for the communications traffic links since both types of link will share the same satellite transponders.
- the Intersatellite Links (ISL's) — antenna steering requirements, frequencies, FDM / TDM / CDM access schemes, modulations, protocols; these must match for the space network WAN's to operate.

Other aspects to also consider in defining the system architecture are:

- the User Access Control
- the system Timing and Synchronization.

This applies especially if "cross border" operability of the User terminals is required, with open access of the Users into the Net via any of the constituent satellites, irrespective of the satellite's owner or operator. But this would not ignore User billing considerations and the location of the User's account.

The "plug in" satellite design concept builds on the demonstrated NASA Advanced Communications Technology Satellite (ACTS) communications system design and protocols. It uses a sophisticated baseband processor (BBP) to dynamically route the communications traffic data cells between and among the uplink, downlink and inter–satellite link antenna beams in real time according to the User's requirements. To this end, it combines a number of the note worthy results and ideas already published by other workers in the broadband communications field with several new system design and performance approaches conceived and engineered by the author. It also builds on some of the satellite system design ideas the author conceived for the KaSTAR FCC filing[2].

3. COMMUNICATIONS TRAFFIC LINKS

It is not absolutely necessary for all the GEO satellites to be in the same traffic link communications frequency band or to use the same modulation schemes. If any satellite system operators were willing to accept the market consequences of a reduced access capability — capacity, data rate, and "cross border" portability — for their clients there would be no reason they could not use a C or Ku–band satellite instead of a Ka–band one. Only the intersatellite links and communications protocols must be standardized (it is considered impractical and unrealistic to make a satellite BBP which can perform protocol conversions between communication, ground network, and intersatellite links).

The network will be carrying all types of traffic in a digital form. Because the ATM standard has become the *de facto* standard worldwide for such multi–traffic networks, it would make sense to constrain the network satellites to only handle traffic complying with the ATM standard.

The reasons for restricting the network and system interface traffic to the ATM standard have also been well described by Ellen M. Hancock (IBM Networking Systems)[3]:

> "ATM's impact will be profound. It will be the springboard to the next great leap forward in communications. Why? Because ATM is not just another networking technology. It offers four key advantages and advances:
>
> 1. ATM increases the amount of information a network can carry — multiplying capacity not by tens, not by hundreds, but by thousands
> 2. ATM is an outstanding technology for mixing data, voice, text, image and video — and delivering them all simultaneously over a single network
> 3. ATM offers a base for integrating networks of all types and sizes: local–area networks, wide–area networks, and later, nationwide and worldwide "information superhighways," and
> 4. ATM promises to be a rare thing in our industry: a true standard, embraced by all the major suppliers — and not in just one country, but worldwide."

As she notes, ATM is rapidly becoming — or, in reality, has *already* become — the de facto worldwide standard for high speed digital communications. And the major networking companies and telephone carriers — for example: Hughes LAN Systems[4], IBM Networking Systems, AT&T[5,6,7], and BellCore — have already adopted, or are adopting, ATM as *the* standard for their future systems and are developing and producing the corresponding equipment. This is because being *cell* based rather than packet based, ATM has proved to be capable of carrying any type of information and of being simpler and faster than the competing packet based systems (Ethernet, FDDI, etc.).

Finally, ATM is a scaleable technology, ranging in speeds from less than 12 Mbps up to 48 Gbps *per user*. In contrast, FDDI and Fast Ethernet, for example, provide data rates of 100 Mbps but that is shared among all users on the network.

Therefore, the proposal is that each "plug in" satellite should be designed to act as an ATM switch in a national or global ATM network — Figure 2[8]. The *need* to restrict the communications traffic to the one ATM standard is dictated by the technological difficulty and financial cost of producing a baseband processor for traffic routing that can handle multiple standards.

But we must also consider the use of the SDH and SONET protocol because of the speed with which fiber optic links using these protocols are taking over in the landline market. However, this also means the network satellites must provide an equivalent OC–3 (155.52 Mbps) — or even OC–12 (622.08 Mbps) — capability, for example, since they must inevitably interconnect fiber links if the new satellite networks are to make any penetration of the evolving high rate data communications market. But, in order to be economically viable by servicing the largest possible percentage of the available User market, they must also handle the emerging ATM applications at STS–3 rates as well as the traditional and lower rate VSAT, telephone, and similar T1 rate applications.

Hence, as a further refinement intended to make the satellite better suited for both connecting to and interconnecting the fiber optic terrestrial network designs now being rapidly deployed, the payload must be specifically designed to also handle the Synchronous Optical Network (SONET) and Synchronous Digital Hierarchy (SDH) protocols, two additional open system standards. Since, to some extent, SDH is the international and extended performance version of SONET, we will concentrate on the SDH application — Figure 3[9]. A prime attribute of SDH as a very high rate transmission protocol is that its structure also offers visibility to low rate signals embedded in the composite high rate signal; for example, to 64 kbps signals in a composite 155.52 Mbps signal. This renders it a perfect mate for the ATM burst transmission protocol, the ATM 3 microsec duration cells being packaged within the 125 microsec Synchronous Transport Module–1 (STM–1) base 155.52 Mbps frame format. Thus, using this base frame SDH / ATM format for the high rate uplinks and downlinks will allow us to merge high rate (155.52 Mbps) and lower rate (≥ 1.544 Mbps) User traffic signals in a common burst transmission protocol. Rates above 155.52 Mbps will be handled by the HIPPI / SONET rate partitioning approach to be discussed under: Ground Network RF Communication Links, below.

Pragmatism demands we also place some additional limitations on the way the system network is set up and operates. Cellular and PCN voice traffic is of its nature very low data rate: some 5 kbps or less is typical. While it is perfectly feasible to design the system to allow direct duplex communication between a *cellular* handset and the satellite, the low data rate requirements introduce an unnecessary restriction on the system design and also fail to correctly utilize the high data rate / broadband attributes of the Ka–band system. Additionally, because of the very much lower RF power ratings of *PCN* handsets it is not similarly possible to achieve direct duplex communications with a satellite for PCN. Therefore, it is deemed more realistic to only interface with the cellular / PCN systems through relay terminals at the cellular / PCN switch or some other base station.

This has the additional advantages of: (a) avoiding having to boost the handset radiated power levels to medically hazardous levels — that is, some 15 dB above the medical limit of 7.7 mW at Ka–band at 8.5 cm distance from the antenna[10]; and (b) avoiding the problem of only being able to communicate between the handset and the satellite at Ka–band when the handset is operated outside of buildings. Thus the relay terminal couples the terrestrial cellular / PCN network, including its interior–to–building local loops, into the satellite network at reasonable power levels for the space / ground link and at appropriately high aggregate data rates. In fact, this overall system design for mobile communications in the year 2000 is very succinctly summarized in Figure 4[11]; it will be noted that the handsets *always* communicate directly with some form of a terrestrial station, either fixed or mobile, and *never* directly with the satellite.

With this modification, the traffic defined above will divide into five user groupings:

i. Residential VSAT or USAT
ii. Business VSAT or USAT
iii. Wideband mobile
iv. Aeronautical
v. Fiber optic cable network restitution / coupling of fiber optic network nodes.

These groupings will be used to define the data rate and bandwidth requirements for the network "plug in" satellite design. The basic characteristics of these services are summarized in Table 1[12][13][14], which indicates the traffic data rates fall into a few well defined bands:

- 64 kbps — 256 kbps
- 256 kbps — 1.5 Mbps
- 1.5 Mbps — 6 Mbps
- 155 Mbps — 622 Mbps

Again, pragmatism would suggest adjusting these bands to use the accepted standards for communications rates:

- ≤ 384 kbps (Quarter T1)
- 384 kbps — 768 kbps (Half T1)
- 768 kbps — 1.544 Mbps (T1)
- 1.544 Mbps — 6.312 Mbps (T2)

- 155.52 Mbps (ATM / OC-3 / STS-3)
- 155.52 Mbps — 622.08 Mbps: SONET Stripes over multiple 155.52 Mbps channels.

Therefore, using Table 1 the transmission rate requirements of Table 2 are derived. This Table also includes the ISL requirements which will be discussed later, and assumes an example satellite payload architecture similar to that shown in Figure 5[15]. The payload generates an equal number of equal sized and overlaid uplink and downlink spot beams, in this case 48 of each, each beam being 120 MHz wide. This is also the same basic beam architecture as is used by the current GEO Ka-band system filings with the FCC. As will subsequently be seen, eight ISL channels, each 120 MHz wide, can be FDM'd into a 1000 MHz wide ISL beam, making a total of 56 x 155.52 Mbps input and output channels. The important point is that, in this example,1 the BBP will have 56 identical input ports and 56 identical output ports, save that the demodulators for the ISL input channels do not have to make an FDM to TDM conversion.

Each satellite's communications payload comprises a baseband processor (BBP) subsystem between the outputs of the uplink LNA's and the inputs of the downlink HPA's. The BBP is operating at TDM downlink data rates per beam up to 155.52 Mbps and performing the functions of digital demuxing of the FDM uplink data, QPSK demodulating the data, matrix switching / routing the individual cells based on their header addresses, time division muxing the new groups of cells, and QPSK modulating the TDM downlink data stream. Thus, the BBP subsystem is an ATM cell processor and router, taking in cells from an FDM uplink and regrouping the cells into TDM streams for the downlinks.

The satellites will take an advanced approach which utilizes the dynamic routing features of the ATM protocol. Therefore, we will not continue the FSS / DBS / DHS tradition of one User per transmission channel sending a continuous data stream; instead, we will TDM multiple data rate, multiple Users into the one fixed bandwidth traffic channel. Nor will we use a signal control channel (ISDN, Teledesic) or an Orderwire system (suggested in the FCC filings for most of the GEO Ka-band systems) to control the channel assignments and routing; instead, we will use the ATM cell header VP / VC identifiers to control the channel TDM'ing and routing. The resultant system will take maximum advantage of the inherent asynchronous nature of the ATM protocol, thus providing maximum flexibility and communications performance to the Users.

Table 2 indicates a particular recommended mix of FDM'd uplink subchannels per beam. This mix is based on a User data rate upper limit of 6.312 Mbps (Table 1) with rates of ≤ 6.312 Mbps being TDM'd into the ATM stream. The data rates and bandwidths of Table 2 assume a shortened (216,232) Reed-Solomon code with a code rate of 0.93[1617] and a QPSK demodulator with a 0.2 roll-off response factor.

The 155.52 Mbps high rate channel will use the entire beam bandwidth and, therefore, the beam has to be set for either this high rate channel or the mix of lower rate channels; it cannot be set for the entire rate capability from 384 kbps to 155.52 Mbps at the same time. Hence, the BBP will include a switch to swap the beam between the single high rate channel and the mix of lower rate channels; this switch will be preset by telecommand from the Network Control Center and will not be controlled by the ATM cell header VPI / VCI.

It is not clear whether any of the other GEO Ka-band systems will use ATM or, indeed, what packet transmission standard(s) they will use. However, since the beam assignments and traffic management are defined in most of the FCC filings to be controlled by a separate Orderwire channel, the implications are these other programs will not use data cell / packet headers for traffic routing and will not, therefore, use the ATM (or similar) transmission standards. Teledesic will not use ATM, using instead a unique 512 bit data packet. In all cases the proposing organizations claim their packet transmission format will be *compatible* with the ATM cell structure — this could simply mean the ATM cell can be carried inside the "native" packet. It is, of course, not ruled out that any of these systems might convert to the ATM form before they actually appear as hardware.

The lower rate uplink channels — 384 kbps, 768 kbps, 1.544 Mbps and 6.312 Mbps — will use a simpler four ATM cell frame format: Figure 6[18]. This uses four ATM cells packaged into a (232,216) Reed-Solomon code word. This format is more suitable for an FDM / TDM burst protocol than is the SDH / ATM format. The BBP will then multiplex these four cell frames into the downlink frame formats of the appropriate routing beams.

The downlink format will use the base STS-3 (known in Europe as: STM-1) 155.52 Mbps frame format of the SDH protocol — Figure 3. As can be seen, the associated Administrative Unit (AU-4) can carry 44 ATM cells, each of 3 microsec duration. In this case, the ARM cells form Tributary Units (TU's) and the set of four cells in a Reed-Solomon codeword a Tributary Unit Group (TUG). The TU and TUG enable lower rate signals — for example: 1.544 Mbps and 6.312 Mbps — to be carried in the high rate STS-3 AU-4.

Any User terminal will receive the complete 155.52 Mbps STS-3 frame format, but will use successively the AU-4 pointer of the AU plus the H4 pointer of the VC-4 plus the ATM cell headers to identify and locate the cells applicable to that particular terminal.

The 155.52 Mbps uplink channel case will use the same

STS–3 / ATM frame format. Indeed, on the occasions the satellite is acting as a fiber optic node coupler with dedicated 155 Mbps uplink and downlink beams, the uplink and downlink formats will probably have a different underlying structure than the ATM one defined in this paper; the format structure will be defined by the terrestrial fiber optic network operator. But since the end points are fixed and unique, and the BBP acts almost in a bent–pipe mode, this difference from the specification we have defined should not matter.

The uplinks and downlinks and ISL's will be QPSK modulated. An 8PSK (or higher ordnance) modulation could also be used, in a Trellis code scheme.

In order to demonstrate these proposed interface and performance standards are both realistic and pertinant, an example Uplink Budget for the 6.312 Mbps data rate through 1 meter ground terminals is shown in Figure 7 for the clear sky and the rain cases. In both cases the beam center condition is given. The goal is to achieve a BER of $1E^{-10}$. As can be seen, to achieve this the ground terminal needs to have either an adjustable output power level — from 0.41 W to 3.1 W in this case — or, as is more probable, the higher power level (3 W) will be used in all cases.

Similarly, an example Communications Downlink Budget for *all* uplink data rates into the same 1 meter ground terminals is shown in Figure 8 for the clear sky and the rain cases. In both cases the beam center condition is given, and satellite payload transponder amplifiers of 30 W are assumed — these are within the range of the amplifiers proposed for the current GEO Ka–band system filings. The goal is to achieve a BER of $1E^{-10}$. As can be seen, the rainfall case does not quite meet the BER goal but is perfectly adequate for digital video, phone and most data traffic. The clear sky case is so good the BER is off the scale! (The Excel 5.0 Spreadsheet complementary error function cannot handle BER's better than about 1E-14).

Hence, a 1 meter ground terminal with a 3 W amplifier and an approx. 300°K LNA / receiver would serve as a fine User terminal for the 6.312 Mbps Business VSAT / USAT market of Table 1.

Finally, Figure 9 shows the equivalent T1 (1.54 Mbps) uplink case for a 0.65 meter USAT terminal with a 1.8 W amplifier; as can be seen, this case also works very well.

4. GROUND NETWORK LINKS

These are identified as one of the critical interfaces in Figure 1, the reason being it is impossible (or unrealistic) to think in terms of a space–based network being a separate isolated entity from the already existing and fast developing terrestrial networks. Hence, the space–based networks must be interconnected with the ground networks — if for no other reasons than that the GII will truly be an integrated whole.

The ground network RF connection links will use the same satellite uplinks and downlinks as the business and residential user terminals (Figure 1). The difference will be in the data rates: the ground networks will unquestionably be using the 155 Mbps and higher rates. Hence, the protocols will be as have already been discussed for the Communications Links, above.

Fiber optic network data rates will be in the ranges above 155.52 Mbps into the multiple Gbps. In order to route this traffic over broadband satellite channels the SONET Stripes approach[19] over several beams will be used for rates above 155.52 Mbps (OC–3): data rates above OC–3 (155.52 Mbps) are accommodated by subdividing into OC–3 channels, or "SONET Stripes." The NASA/JPL and Los Alamos Labs HIPPI / SONET communication link experiment on ACTS has successfully demonstrated the Stripes approach for rates up to 622.078 Mbps (OC–12).

5. INTERSATELLITE LINKS

Any global network will include multiple satellites in different orbital slots. In order to avoid the "multiple hop" and the consequent 250 msec delay per hop when a communications path needs to pass over several satellites, the individual satellites will be interlinked by microwave or optical Intersatellite Links (ISL's). Thus, there will be no need to pass through intermediate ground stations and the total delay can be kept below 500 msec for two satellites.

At least for the early systems the Intersatellite Links will be in the 60 GHz band — later ones may use optical links, but the laser technology does not yet have adequate power capability — and the best approach is to treat them as additional uplink and downlink beams with the same peak data rate per channel as the communication beams: 155.52 Mbps, and also in compliance with the ATM standard. Thus, to the BBP the communications and ISL beams will appear identical and the ISL beams will simply be treated as additional and identical traffic routing ports. The actual number of required ISL channels depends on a detailed traffic and marketing analysis but, based on what other comparable programs have determined to be the requirement , a baseline ISL capacity of 1 GHz divided into eight 155 Mbps channels is selected. The ATM cells will be TDM'd into each of these channels; thus, the ISL channels are identical in format and rate to the communication downlink channels. That is, the ISL's will use the same 155.52 Mbps STS–3 / ATM frame format as these high rate uplinks and downlinks. In this case the end points are also fixed and unique: the companion satellites.

An example ISL link budget is shown in Figure 10. This assumes eight separate channels FDM'd into the 1 GHz band. Each channel has its own output power amplifier as shown on Figure 5. In the budget, the Nominal Link corresponds to two satellite at 90° angular longitudinal separation; the Worst Case corresponds to 162.5° separation — this latter is the maximum separation at GEO before the satellite crosslink is blocked by the earth. *As can be seen from the budget, the link works well in both cases with a 0.75 meter antenna and a 15 W amplifier per 155.52 Mbps / 120 MHz channel.*

An antenna beam width of 0.47° at the ISL frequency of 60 GHz is needed to ensure the target receiver satellite can be acquired by the transmitter satellite without too much difficulty once the satellites are both at GEO, and that relative drift motions of the two satellite will not cause loss of the link. However, the need to link satellites at different angular separations with a common ISL design requires the ISL antennas include a steering capability.

The steerable antenna option would require being able to slew the antenna beam through 37° in negative pitch (i.e., pitch down) from the nominal case corresponding to the 90° satellite separation. This could be accomplished with a simple jack screw on one edge of a reflector dish or with an active phased array antenna.

It should be noted the intention is not (normally) to be slewing the ISL antenna repeatedly between different target satellites in the net. Rather, the antenna will be steered to link with the designated targets and then left in that fixed position. Retargeting will only be required for reconfiguration of the net when a satellite dies or another one is "plugged in."

6. USER ACCESS CONTROL

One of the problems to be grappled with is that of the User Access and network control. Traditional terrestrial networks and satellite-based "bent pipe" communication networks have, until now, always included a network control center (NCC) responsible for allocating network resources to Users, for monitoring the network status and for rectifying failures and contention problems — the "plug in" satellite ground control station in Figure 1. This concept would, if followed for the "regenerative" payload satellite, require the uplink FDM channel allocation and the satellite payload on-board switch be configured and controlled by a ground-based NCC. This would normally be done with an in-band Signalling Channel (e.g, the ISDN "D" channel) or an Orderwire system, the latter being either run over the satellite payload as a bent pipe channel between Users and the NCC or via the PSTN. Thus, Users wishing to access and use the system would submit their request for channel space and traffic routing to the NCC which would then allocate a frequency band and set up the network to correctly route the User traffic.

But such an approach places an operational bottleneck in the system and tends to assume Users will be relatively long term rather than short term — that is, channel allocations and switch settings will be made for relatively long periods and usage will not generally include transient, short term, or bursty traffic. *It is thus a continuation of the current "bent-pipe" FSS / DBS / DTH / DHS capacity allocation approach. It also fails to take advantage of the very strong ATM attributes for autonomous traffic routing, using the cell header and its VPI / VCI markers for routing the traffic and handling bursts.* Therefore, this paper takes the approach of Figure 1:

- A Network Operations Center (NOC) is included as part of the Satellite Operations Center (SOC) in the satellite operations segment. This NOC monitors the network status and take corrective action in the event of network problems. It also handles the booking of usage charges and the billing of Users — the BBP includes a control processor which downlinks data on traffic routing for billing purposes.

- The SOC controls the satellite(s) via the TT&C system and is responsible for monitoring and controlling the satellite subsystem health and the satellite orbital stationkeeping maneuvers.

- Gateway terminals provide connections to the PSTN, to fiber optic cable nodes, and to other terrestrial network nodes.

- Personal communications users access the system with VSAT's (~ 2 meters diameter) or USAT's (~ 0.6 meter diameter) depending on data rate. These Users include single user cellular / PCN relays, mobile multi-media, fixed multi-media, and airborne multi-media terminals.

- Private Business and Residential Users access the system using VSAT's / USAT's.

- The traffic routing at each switch, both satellite-based and terrestrial, is determined automatically by the switch using the VC / VP identifiers of the ATM cell header. The routing is initially setup using the Flow Setup and Routing approach of the ATM Forum / CCITT Q.93B specification.

The BBP functional block diagram of Figure 5 includes a Control Processor, and this immediately prompts the idea of a User Access Control Channel directly interfaced into the Control Processor. This channel would be used in conjunction with the ATM Flow Setup and Routing protocol to allocate uplink bandwidth to a User and to establish the end-to-end connections the User requires.

In this approach there will be a dedicated 64 kbps data rate, fixed frequency RF channel at one end of each of the uplink and downlink bands adjacent to the satellite

TT&C channels. This channel will be FDM'd into 232 subchannels, each of 64 kbps data rate. Any User terminal wishing to communicate over the satellite will send the request for an uplink channel assignment and the associated data rate specification over one of the subchannels of this control channel. The access to these subchannels will be by Slotted ALOHA random multiple access protocol. The access control traffic will use the same ATM standard format as the main communications uplink channels, but at the 64 kbps data rate. In the payload, this control channel will go directly to the BBP control processor which will assign the communications channel based on the requested data rate and the channel availability.

The BBP will respond to the User terminal via the corresponding access control channel downlink to give the assigned uplink frequency and time slots. This downlink, just like the main communications beam downlinks, will be single TDM data stream, but the rate will be 15.5 Mbps and the downlink frame format will be identical to the uplink one: four ATM cell Reed–Solomon code word formats TDM'd into the single data stream. That is, the SDH / ATM frame formats will not be used since the needs of the access control links do not justify such a complex structure.

Once the User terminal has established the RF uplink on the assigned channel, the flow setup and routing is handled over the main communications channel according to the ATM Forum UNI 3.1 (UNI 4.0) / CCITT Q.2931 specifications. The User terminal sends a SETUP message which includes a flow specification. The BBP control processor will issue a CALL PROCEEDING message back to the User terminal which contains the network–assigned (i.e., processor–assigned) VPI and VCI for the connection, and issues the request for the downstream switches to accept the traffic based on the routing specification.

The example Access Control channel link budgets are shown in Figures 11 and 12. In both cases, and for obvious reasons, the User terminal characteristics match those of the User terminals in the communications channels link budgets: Figure 7 and 8. For the uplink budget one change was made: the terminal amplifier power was set at 3.18 W for both clear sky and rain conditions. This correlates with the earlier comments on the most probable terminal design and also provides an adequate BER in both cases — a BER of 1E-6 is judged to be adequate for the purposes of this control channel running at 64 kbps.

The rainfall case can be improved from the BER of 1.25E-2 to better than 1E-6 either by increasing the terminal amplifier power to around 12 W — judged impractical and unnecessary — or by increasing the satellite access channel antenna size to around 0.5 meter from the present 0.25 meter of Figure 18. Since the same antenna is used on the satellite for both the uplink and downlink, the clear sky downlink BER (Figure 19) improves beyond 1E-12 and goes off the scale while the rain BER increases to 1E-9. Such a downlink BER improvement is unnecessary and could be avoided by using two separate antennas of 0.5 meter and 0.25 meter for the uplink and downlink respectively. But this will bring mass and cost increases and would, therefore, have to be more carefully traded against the uplink BER in rainfall conditions with the common 0.25 meter antenna.

7. TIMING AND SYNCHRONIZATION

Timing is a critical issue for any TDM VSAT communication system, and especially so for one operating at high data rates up to 155 Mbps. At the speed of light each nanosecond of transmission time corresponds to 11.81 inches distance; hence, two User seeing an effective transmission path length difference of, say, 3000 feet due to altitude and longitude / latitude differences will see a clock difference of 3.048 microsecs. At a data rate of 155.52 Mbps this is equivalent to a complete ATM cell! At a rate of 155.52 Mbps the bit duration is 6.43 nanosecs. The SDH / ATM downlink format proposed to be used for the main communications has eight spare bytes in the VC–4 virtual container, corresponding to 411.52 nanosecs duration. Therefore, to avoid the possibility of cell losses due to clock differences the User clocks and the Payload BBP clock must all be synchronized to better than this 8–byte duration, or better than 200 nanosecs, say. The potential solutions are:

a. To include a master clock broadcast transmission in the downlink beams, probably using the User Access Control downlink channels. Then each User terminal and the switch control processor of the Payload BBP would have to perform an interactive procedure during the initial User access request to measure and calculate the Difference Time Of Arrival (DTOA) of this clock at the User. Thereafter the User terminal would correct the transmission time of the uplink bursts and the reception time of the downlink bursts to compensate for the clock delay over the transmission path to and from the satellite. The approach of having the User terminals make ALL the compensations is chosen here simply to avoid the extreme complexity involved in having the BBP make the corrections for each of a multitude of separate and different input channels. In the proposed approach the BBP would only correct for uplink Doppler effects and would assume a passive role for clock delay effects. The effective accuracy depends on the satellite clock accuracy and the DTOA measurement / calculation accuracy, but it should be possible to achieve the desired 200 nanosecs figure.

b. To include a GPS receiver in each User terminal and in the Payload BBP — in fact, because a GPS receiver on a GEO–satellite cannot adequately receive the GPS satellite transmissions, a GPS receiver would be included in the Network Control Center and the BBP clock slaved to that via the TT&C subsystem. Suitable single card receivers are available with 100 nanosec (SA) / 150 nanosec (w/o SA) accuracy of the timing outputs with respect to GPS or UTC time. The GPS receiver would not only provide an accurate clock reference, it would also output the exact location of the User terminal to within 10 meters. Hence, a simple computer algorithm would produce the corresponding transmission and reception clock corrections based on the User location and the satellite ephemerides. The clock error of 100 nanosecs dominates the position error of 10 meters — equivalent to 33.3 nanosecs. Hence, the total RSS error will be 105.4 nanosecs.

Of the two, the GPS receiver approach is selected as being the most accurate, simplest, most robust and — overall — least expensive solution.

8. CONCLUSIONS

We have shown it should pose no insurmountable technical problems for the various proposing satellite-based broadband system suppliers to institute an Internet-similar "open architecture" system design solution for the new satellite-based broadband networks. Thus, they would mutually define the overall system design architecture of these networks and issue agreed "open" specifications for the interfaces: the intersatellite, ground network, user access and communications traffic links.

We have proved the feasibility of this approach by selecting a suitable set of open system standards and demonstrating the basic corresponding communication system performances. The selected standards are:

- ATM and SDH for the overall protocol:
  - a four ATM cell frame for the communications and user access control uplinks below 6.312 Mbps
  - a four ATM cell frame for the user access control downlinks
  - SDH / STS-3 (STM-1) frame with an underlying four ATM cell structure for the 155.52 Mbps communications and ground network uplinks
  - SDH / STS-3 (STM-1) frame with an underlying four ATM cell structure for the 155.52 Mbps communications and ground network downlinks
  - SDH / STS-3 (STM-1) frame with an underlying four ATM cell structure for the 155.52 Mbps intersatellite links
- FDM / TDM for the communications, ground network, intersatellite and user access control uplinks
- TDM for the communications, ground network and user access control downlinks
- QPSK or 8PSK modulation for all links
- Reed-Solomon coding for all links
- Traffic routing / switching in the satellite baseband processor on the basis of the ATM cell header VPI / VCI
- Intersatellite Links in the 60 Ghz ISL band: LHCP 59.50 / 60.50 GHz, RHCP 62.50 / 63.50 Ghz
- Additionally, the ISL antennas must be capable of being steered in negative pitch by at least 37° from the nominal case corresponding to the 90° angular separation between adjacent satellites.

The result is a system design solution allowing any satellite system operator to procure satellites from any supplier for insertion into a truly global and multicultural "Global Information Infrastructure." What better way to bind the populations of all nations together into one homogeneous whole? The consequent profit potentials — both social and monetary — are enormous.

9. REFERENCES

1. *Establishing The Satellite-Based Infobahn In A Multicultural World — The Importance Of Open System Standards;* John F. Purchase; pg. 18 – 22, *Via Satellite* Magazine, July 1995; Phillips Business Information, Inc.

2. *Application of KaSTAR Satellite Communications Corp. For authority to construct, launch and operate a Ka band digital domestic fixed communications satellite system;* Rini & Coran, P.C., Attorneys at Law; Washington, D.C.; July 12, 1995.

3. *Asynchronous Transfer Mode — The Coming Revolution;* Ellen M. Hancock, IBM Networking Systems; World Communications and Technology 1994, Sterling Publications Limited.

4. *Asynchronous Transfer Mode — The Future Of Global Networking;* Bobby Murphy and Anthony Alles, Hughes LAN Systems; World Communications and Technology 1994, Sterling Publications Limited.

5. *A 160 Gb/s ATM Switch Prototype Using The Concentrator-Based Growable Switch Architecture;* Kai Y. Eng, Mark J. Karol, Gregory J. Cyr, Mark A. Pasham; AT&T Bell Laboratories; pg 550 – 554, IEEE International Conference on Communications, Seattle; June 1995.

6. *BAHAMA: A Broadband Ad-Hoc Wireless ATM Local-Area Network;* K.Y. Eng, M. J. Karol, E. Ayanoglu, et al; AT&T Bell Laboratories; pg 1216 – 1223, IEEE International Conference on Communica-

tions, Seattle; June 1995.

7. *Distributed–Queuing Request Update Multiple Access (DQRUMA) for Wireless Packet (ATM) Networks;* K.Y. Eng, M. J. Karol; AT&T Bell Laboratories; pg 1224 – 1231, IEEE International Conference on Communications, Seattle; June 1995.

8. *B–ISDN / ATM Fast Packet Switching Experimental Payload;* Lawrence White, et al; COMSAT Laboratories; pg 1272 – 1282, 15th International Communications Satellite Systems Conference; San Diego, CA; February 28 – March 3, 1994. The Figure is based on the Figure 1 of the reference.

9. Ibid., Dr. Marcos Bergamo.

10. *Personal Satellite Communications Utilizing the Ka–Band;* E.J. Hayes, J.M. Keelty, M.J. Wlodyka; First International Conference on Universal Personal Communications; Dallas, TX; September 29 – October 2, 1992. The figure is based on the Figure 2 of the reference.

11. *The Flexibility of ATM: Supporting Future Multimedia And Mobile Communications;* Heinrich Armbrüster; Siemens AG.; pg. 76 – 84, IEEE Communications Magazine, February 1995.

12. *Canada's Advanced Satcom Program;* Edward J. Hayes; Communications Research Centre, Canada; pg. 24 – 29, PTC'95, Hawaii; January 1995. The Table is partly based on the Figure 3 of the reference.

13. *Advanced Topics in ATM Networks;* Prof. Anujan Varma, University of California; IEEE International Conference on Communications, Seattle; 22 June 1995. The Table is partly based on a presentation chart from the reference.

14. *An Architectural Framework For ATM Networks;* Raif O. Onvural, IBM; IEEE International Conference on Communications, Seattle; 18 June 1995. The Table is partly based on a presentation chart from the reference.

15. Ibid., Lawrence White et al. The Figure is based on the Figure 8 of the reference.

16. Ibid., Lawrence White et al.

17. Ibid, Dr. Marcos Bergamo.

18. Ibid., Lawrence White et al.

19. Ibid., Dr. Marcos Bergamo.

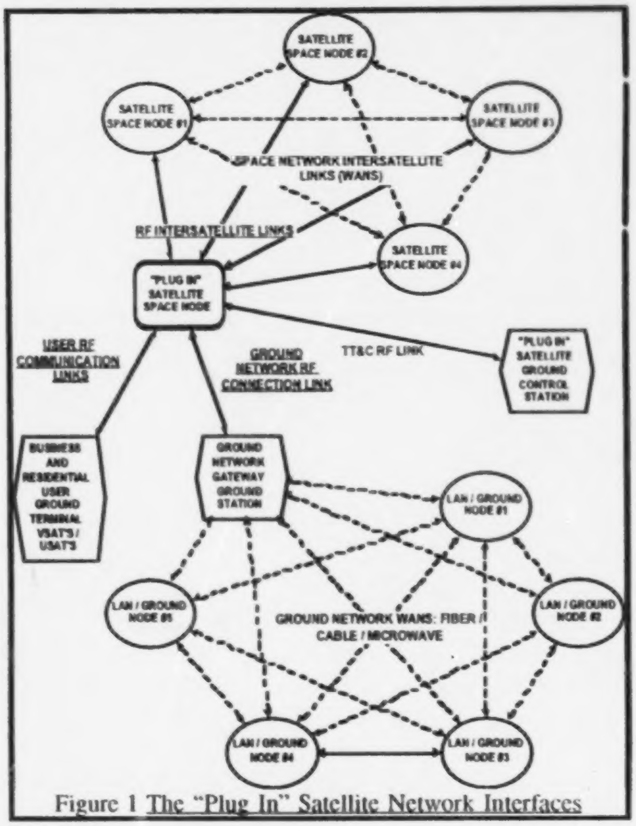

SATELLITE SPACE NODE #2
SATELLITE SPACE NODE #1
SATELLITE SPACE NODE #3
SPACE NETWORK INTERSATELLITE LINKS (WANS)
RF INTERSATELLITE LINKS
SATELLITE SPACE NODE #4
"PLUG IN" SATELLITE SPACE NODE
USER RF COMMUNICATION LINKS
GROUND NETWORK RF CONNECTION LINK
TT&C RF LINK
"PLUG IN" SATELLITE GROUND CONTROL STATION
BUSINESS AND RESIDENTIAL USER GROUND TERMINAL VSAT'S / USAT'S
GROUND NETWORK GATEWAY GROUND STATION
LAN / GROUND NODE #1
LAN / GROUND NODE #5
LAN / GROUND NODE #2
GROUND NETWORK WANS: FIBER / CABLE / MICROWAVE
LAN / GROUND NODE #4
LAN / GROUND NODE #3

Figure 1 The "Plug In" Satellite Network Interfaces

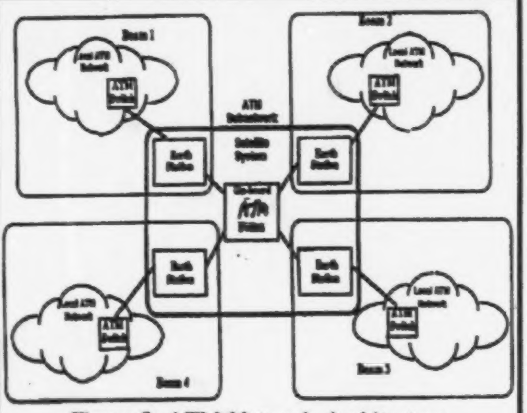

Beam 1
Beam 2
Beam 3
Beam 4
ATM Subnetwork
Satellite System
ATM Switch

Figure 2 ATM Network Architecture

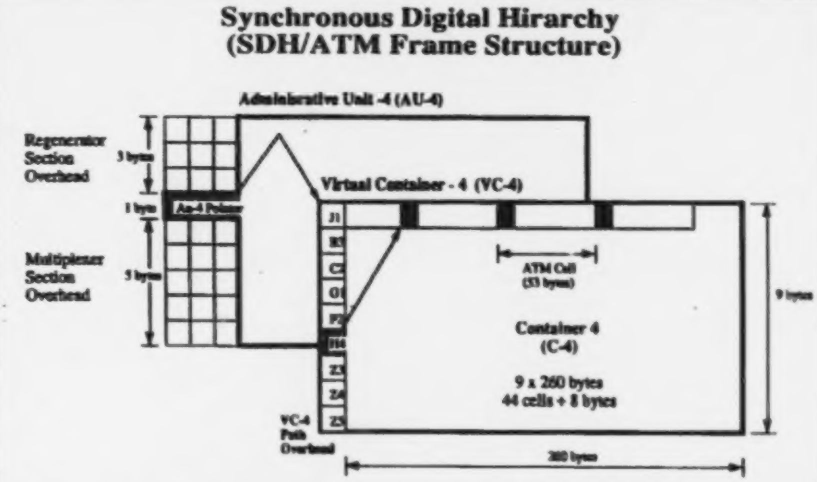

Synchronous Digital Hirarchy
(SDH/ATM Frame Structure)
Administrative Unit -4 (AU-4)
Regenerator Section Overhead
3 bytes
1 byte
AU-4 Pointer
Multiplexer Section Overhead
5 bytes
Virtual Container - 4 (VC-4)
J1
B3
C2
G1
F2
H4
Z3
Z4
Z5
ATM Cell
(53 bytes)
Container 4
(C-4)
9 x 260 bytes
44 cells + 8 bytes
9 bytes
VC-4 Path Overhead
260 bytes

Figure 3 155.52 Mbps Uplink, Downlink and ISL SDH / ATM Frame Format Structure

Service	Traffic	Bit Rate Range	Band	Application
Residential VSAT / USAT	Voice, data, low rate video. Multimedia	64 kbps — 256 kbps. 265 kbps — 1.5 Mbps	Ka	Residential access to information highway. Wideband VSAT / USAT for small businesses and telecommuters
Business VSAT / USAT	Multimedia	1.5 Mbps — 6 Mbps	Ka	Wideband VSAT / USAT for large businesses
Wideband mobile	Voice, data, low rate video	64 kbps — 256 kbps	Ka	Wideband land mobile office
Aeronautical	Multimedia	64 kbps — 1.5 Mbps	Ka	In-flight access to information highway
Fiber optic node	High rate data	155 Mbps — 622 Mbps	Ka	Fiber optic cable restitution and coupling of fiber optic network nodes

Table 1 Summary Of Proposed User Services and Associated Data Rate Requirements

Number Of Beams Per Payload	Beam Bandwidth Used	Number Of Subchannels Per Beam	Subchannel Bandwidth	Subchannel Data Rate
Uplink beams: **48**	**120 MHz**	**FDM subchannels with 5% frequency guard bands:**		**TDM subchannels with TBD time guard bands:**
48	120 MHz	28	4.07 MHz	384 kbps, 768 kbps, 1.544 Mbps, 6.312 Mbps
48	120 MHz	1	100.3 MHz	155.52 Mbps
48 total uplink beams with 1344 total FDM subchannels divided equally among the 48 beams	120 MHz per beam	28 total subchannels per beam, exclusive of the 155.52 Mbps high rate channel		155.52 Mbps total peak per channel / beam
Downlink beams:		**TDM channels:**		
48	120 MHz	1	120 / 100.3 MHz	155.52 Mbps
60 GHz ISL beams:		**FDM channels:**		
1 transmit	1000 MHz	8	120 / 100.3 MHz	155.52 MHz
1 receive	1000 MHz	8	120 / 100.3 MHz	155.52 MHz
48 total uplink beams + 1 ISL receive beam **48 total downlink beams + 1 ISL transmit beam**	**8 x 120 MHz plus 1 x 1000 MHz** **8 x 120 MHz plus 1 x 1000 MHz**	**56 total broad-band input channels** **56 total broad-band input channels**	**120 MHz per broadband output channel** **120 MHz per broadband output channel**	**Up to 155.52 Mbps per channel** **Up to 155.52 Mbps per channel**

Table 2 Example "Plug In" Satellite Payload Transmission Requirements

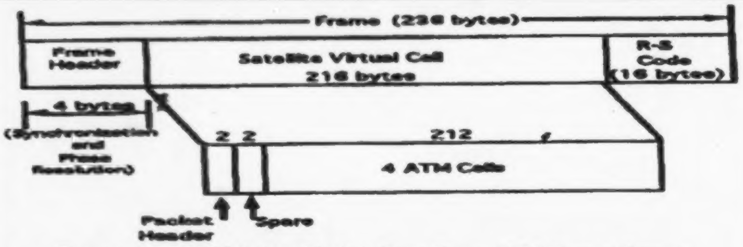

Frame (236 bytes)
Frame Header
Satellite Virtual Cell 216 bytes
R-S Code (16 bytes)
4 bytes
(Synchronization and Phase Resolution)
2 2
212
4 ATM Cells
Packet Header
Spare

Figure 6 ≤ 6.312 Mbps Uplink Data Rate ATM Frame Format

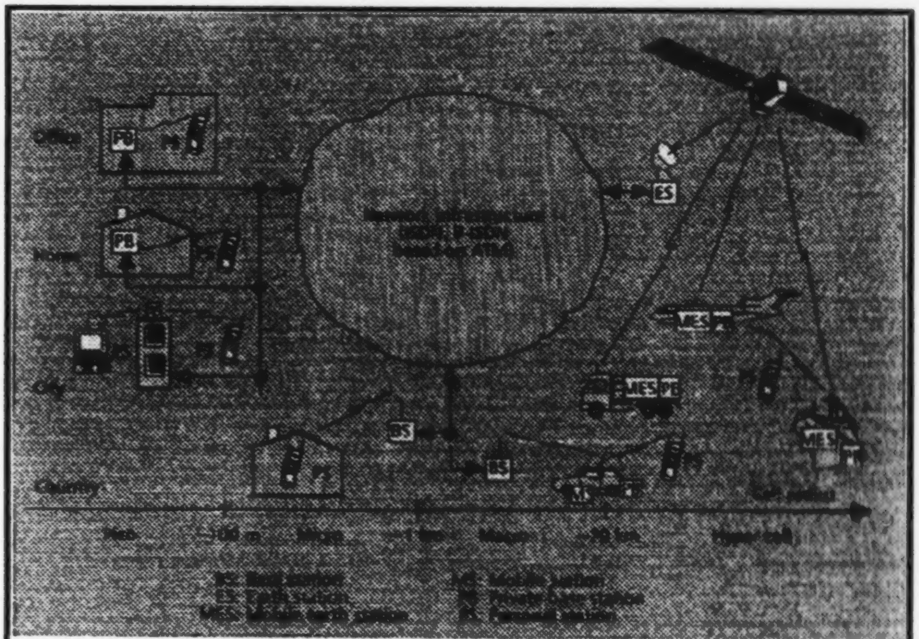

PB
PS
ES
MES
BS

Figure 4 Mobile Communications 2000: Cellular, Pcn And Cordless

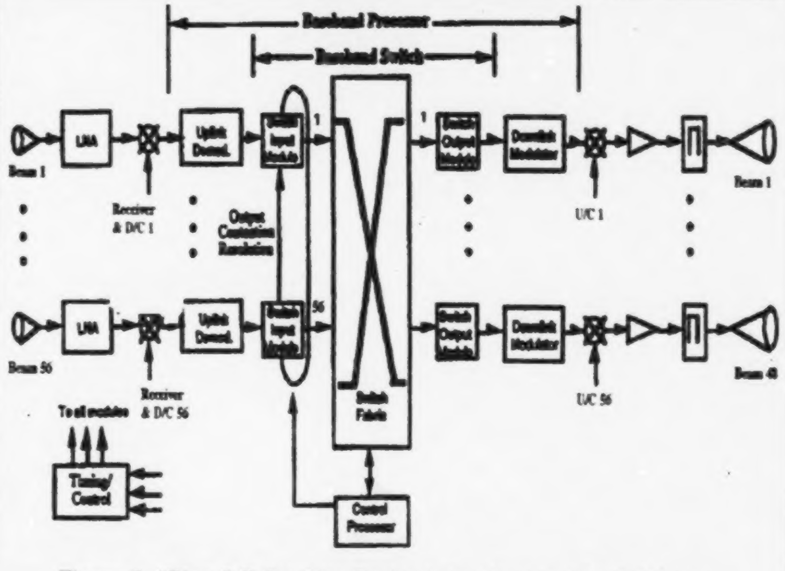

Baseband Processor
Baseband Switch
Beam 1
LNA
Receiver & D/C 1
Uplink Demod.
Output Contention Resolution
Switch Input Module
1
56
Switch Fabric
Switch Output Module
Downlink Modulator
U/C 1
Beam 1
Beam 56
LNA
Receiver & D/C 56
Uplink Demod.
Switch Input Module
Switch Output Module
Downlink Modulator
U/C 56
Beam 48
To all modules
Timing/ Control
Control Processor

Figure 5 "Plug In" Satellite Payload Architecture Block Diagram

	BEAM CENTER, CLEAR SKY	BEAM CENTER, RAIN
	Earth	**Station**
Data rate	6.31Mbps	6.31Mbps
Modulation type	QPSK	QPSK
Modulation roll–off response	0.2	0.2
Code rate of R–S inner code	0.93	0.93
Transmission rate, Mbps	6.79Mbps	6.79Mbps
Required bandwidth, MHz	4.07MHz	4.07MHz
Up-link frequency, GHz	30.00 GHz	30.00 GHz
Transmitter saturated power rating @ output flange, W	0.41W	3.11W
Transmitter saturated power rating, dBW	-3.8dBW	4.9dBW
Transmission line loss, dB	0.50dB	0.50dB
Earth station antenna diameter, m	1.00m	1.00m
Antenna efficiency, %	55%	55%
Antenna gain, dBi	47.3dB	47.3dB
EIRP of earth station, dBW	43.00dBW	51.77dBW
	Earth to	**Space Path**
Altitude, km	35,786km	35,786.0km
Clear sky free-space path loss, dB	213.07dB	213.07dB
Atmospheric losses, dB	0.96dB	0.96dB
Precipitation losses, dB	0.00dB	8.77dB
Antenna pointing loss, dB	0.60dB	0.60dB
Up-link losses, dB	214.6dB	223.4dB
	Satellite	
Satellite antenna diameter, m	1.0m	1.0m
Antenna efficiency, %	55%	55%
Satellite antenna peak gain, dBi	47.3dB	47.3dB
Antenna, noise temp., K	290.0K	290.0K
Feeds,noise temp., K	31.5K	31.5K
LNA,noise temp., K	180.0K	180.0K
Recieving system noise temperature, dBK	27.dBK	27.dBK
Satellite figure of merit (G/Ts), dBi/K	20.3dB/K	20.3dB/K
Pointing error, dB	0.0dB	0.0dB
G/Ts, dBi/K	20.3dB/K	20.3dB/K
C/T @satellite reciever output, dBW/K	-151.28dBW/K	-151.28dBW/K
1/Boltzmann constant, dBW/K/Hz	228.6dBW/K/Hz	228.6dBW/K/Hz
C/kT @ LNA input, dBHz	77.3dBHz	77.3dBHz
C/No, dBHz	77.3dBHz	77.3dBHz
Satellite Transponder Bandwidth, MHz	4.07MHz	4.07MHz
C/N, dB	11.2dB	11.2dB
Eb/No, dB	9.0dB	9.0dB
Coding Gain, dB	4.0dB	4.0dB
Available Eb/No, dB	**13.0dB**	**13.0dB**
BER, 1E-x	**1.33E-10**	**1.33E-10**

Figure 7 Uplink Budget for T2 (6.312 Mbps) Data Rate From a 1.0 Meter User Terminal

	BEAM CENTER, CLEAR SKY	BEAM CENTER, RAIN
	Satellite	
Data rate	155.52Mbps	155.52Mbps
Modulation type	QPSK	QPSK
Modulation roll–off response	0.2	0.2
Code rate	0.93	0.93
Transmission rate, Mbps	167.23Mbps	167.23Mbps
Required bandwidth, MHz	100.34MHz	100.34MHz
Down-link frequency, GHz	20.00 GHz	20.00 GHz
Transmitter saturated power rating, W	30.00W	30.00W
Losses due to multiplexer, filters, couplers, power dividers, ant.	0.5dB	0.5dB
Satellite antenna diameter, m	1.3m	1.3m
Antenna gain, dBi	46.1dB	46.1dB
EIRP, dBW	60.4dBW	60.4dBW
	Space to Earth Path	
Altitude, km	35,786.km	35,786.km
Clear-sky free-space path loss, dB	209.5dB	209.5dB
Atmospheric loss, dB	1.1dB	1.1dB
Precipitation loss margin, dB	0.0dB	7.6dB
Down-link losses, dB	210.6dB	218.3dB
	Earth Station	
Receive earth station antenna diameter, m	1.00m	1.00m
Antenna efficiency, %	55%	55%
Receiver antenna gain, dBi	43.8dB	43.8dB
Receiving system noise temperature, °K	400.00K	400.00K
Earth station clear-sky figure of merit(G/Ts), dB/K	17.8dB/K	17.8dB/K
Pointing error(satellite motion), dB	0.0dB	0.0dB
G/Te, dBi/K	17.8dBi/K	17.8dBi/K
C/Td @ earth station reciever output, dBW/K	-132.5dBW/K	-140.1dBW/K
1/Boltzmann constant, dBW/K/Hz	228.6dBW/K/Hz	228.6dBW/K/Hz
C/kTd @ reciever output, dBHz	96.1dBHz	88.5dBHz
C/No, dBHz	96.1dBHz	88.5dBHz
Transponder bandwidth, MHz	120.00MHz	120.00MHz
C/N, dB	15.3dB	7.7dB
Eb/No, dB	14.2dB	6.6dB
Coding Gain, dB	4.0dB	4.0dB
Available Eb/No, dB	**18.2dB**	**10.6dB**
BER, 1E-x	**0.00E+00**	**8.84E-07**

Figure 8 Downlink Budget For ALL Uplink Data Rates With a 1 Meter User Terminal

	BEAM CENTER, CLEAR SKY	BEAM CENTER, RAIN
	Earth	**Station**
Data rate	**1.54Mbps**	**1.54Mbps**
Modulation type	**QPSK**	**QPSK**
Modulation roll–off response	**0.2**	**0.2**
Code rate of R–S Inner code	**0.93**	**0.93**
Transmission rate, Mbps	1.66Mbps	1.66Mbps
Required bandwidth, MHz	1.00MHz	1.00MHz
Up-link frequency, GHz	**30.00 GHz**	**30.00 GHz**
Transmitter saturated power rating @ output flange, W	**0.24W**	**1.80W**
Transmitter saturated power rating, dBW	-6.2dBW	2.6dBW
Transmission line loss, dB	0.50dB	0.50dB
Earth station antenna diameter, m	**0.65m**	**0.65m**
Antenna efficiency, %	55%	55%
Antenna gain, dBi	43.6dB	43.6dB
EIRP of earth station, dBW	**36.89dBW**	**45.66dBW**
	Earth to	**Space Path**
Altitude, km	35,786km	35,786.0km
Clear sky free-space path loss, dB	213.07dB	213.07dB
Atmospheric losses, dB	0.96dB	0.96dB
Precipitation losses, dB	0.00dB	8.77dB
Antenna pointing loss, dB	0.60dB	0.60dB
Up-link losses, dB	**214.6dB**	**223.4dB**
	Satellite	
Satellite antenna diameter, m	**1.0m**	**1.0m**
Antenna efficiency, %	55%	55%
Satellite antenna peak gain, dBi	47.3dB	47.3dB
Antenna, noise temp., K	290.0K	290.0K
Feeds,noise temp., K	31.5K	31.5K
LNA,noise temp., K	180.0K	180.0K
Recieving system noise temperature, dBK	**27.dBK**	**27.dBK**
Satellite figure of merit (G/Ts), dB/K	20.3dB/K	20.3dB/K
Pointing error, dB	0.0dB	0.0dB
G/Ts, dBi/K	**20.3dB/K**	**20.3dB/K**
G/T @ satellite reciever output, dBW/K	-157.4dBW/K	-157.4dBW/K
1/Boltzmann constant, dBW/K/Hz	228.6dBW/K/Hz	228.6dBW/K/Hz
C/kT @ LNA input, dBHz	**71.2dBHz**	**71.2dBHz**
C/No, dBHz	**71.2dBHz**	**71.2dBHz**
Satellite Transponder Bandwidth, MHz	**1.00MHz**	**1.00MHz**
C/N, dB	**11.2dB**	**11.2dB**
Eb/No, dB	**9.0dB**	**9.0dB**
Coding Gain, dB	**4.0dB**	**4.0dB**
Available Eb/No, dB	**13.0dB**	**13.0dB**
BER, 1E-x	**1.33E-10**	**1.33E-10**

Figure 9 Communications Uplink Budget For T1 (1.544 Mbps) Data Rate With 0.65 Meter User Terminal

	NOMINAL	WORST CASE
	Transmitter	
Data rate	**155.52Mbps**	**155.52Mbps**
Modulation type	**QPSK**	**QPSK**
Modulation roll–off response	**0.2**	**0.2**
Code rate	**0.93**	**0.93**
Transmission rate, Mbps	167.23Mbps	167.23Mbps
Required bandwidth, MHz	100.34MHz	100.34MHz
Cross-link frequency,GHz	**60.0GHz**	**60.0GHz**
Transmitter saturated power rating,W	**15.0W**	**15.0W**
Transmitter saturated power rating,dBW	11.8dBW	11.8dBW
Reserve for end-of life loss,dB	1.0dB	1.0dB
Antenna diameter,m	**0.75m**	**0.75m**
Antenna beamwidth, °	0.47°	0.47°
Antenna efficiency	55%	55%
Antenna gain,dBi	50.9dBi	50.9dBi
Saturated EIRP,dBW	61.6dBW	61.6dBW
Output backoff for # of carriers	0.0dB	0.0dB
Pointing error (attitude control and uncertainty as to where other satellite is located), dB	1.0dB	1.0dB
EIRP,dBW	**60.6dBW**	**60.6dBW**
	Path	
Longitudinal angular separation,°	**90.00°**	**162.50°**
Off-Nadir angle to receiving satellite	0.0°	0.0°
Altitude of recieving satellite,km	35786.0km	35786.0km
Path loss,dB	**223.6dB**	**226.5dB**
	Receiver	
Antenna diameter,m	**0.75m**	**0.75m**
Antenna beamwidth, °	0.13°	0.12°
Antenna efficiency	55%	55%
Antenna gain,dBi	50.9dBi	50.9dBi
Antenna noise temp, °K	2.9K	2.9K
Feeds noise temp., °K	31.5K	31.5K
LNA,noise temp., °K	180.0K	180.0K
Receiver system noise temperature, °K	214.4K	214.4K
Figure of merit,(G/Ts),dBi/K	**27.6dBi**	**27.6dBi**
C/Tx @ receiver output,dBW/K	-135.4dBW	-138.3dBW
1/Boltzmann constant,dBW/K/Hz	228.6	228.6
C/kTx @ receiver output,dBHz	93.2dBHz	90.3dBHz
C/No,dBHz	**93.2dBHz**	**90.3dBHz**
Transponder Bandwidth, MHz	**120.00MHz**	**120.00MHz**
C/N, dB	**12.4dB**	**9.5dB**
Eb/No, dB	**11.3dB**	**8.4dB**
Coding Gain, dB	**4.0dB**	**4.0dB**
Available Eb/No, dB	**15.3dB**	**12.4dB**
BER, 1E-x	**5.55E-17**	**1.82E-09**

Figure 10 ISL Link Budget

	BEAM CENTER, CLEAR SKY	BEAM CENTER, RAIN
	Earth	**Station**
Data rate	**0.064Mbps**	**0.064Mbps**
Modulation type	**QPSK**	**QPSK**
Modulation roll–off response	**0.2**	**0.2**
Code rate	**0.93**	**0.93**
Transmission rate, Mbps	0.069Mbps	0.069Mbps
Required bandwidth, MHz	0.041MHz	0.041MHz
Up-link frequency, GHz	**30.00 GHz**	**30.00 GHz**
Transmitter saturated power rating @ output flange, W	**3.18W**	**3.18W**
Transmitter saturated power rating, dBW	5.0dBW	5.0dBW
Transmission line loss, dB	0.50dB	0.50dB
Earth station antenna diameter, m	**1.00m**	**1.00m**
Antenna efficiency, %	55%	55%
Antenna gain, dBi	47.3dB	47.3dB
EIRP of earth station, dBW	**51.87dBW**	**51.87dBW**
	Earth to	**Space Path**
Altitude, km	35,786km	35,786.0km
Clear sky free-space path loss, dB	213.07dB	213.07dB
Atmospheric losses, dB	0.96dB	0.96dB
Precipitation losses, dB	0.00dB	8.77dB
Antenna pointing loss, dB	0.60dB	0.60dB
Up-link losses, dB	**214.6dB**	**223.4dB**
	Satellite	
Satellite antenna diameter, m	**0.3m**	**0.3m**
Antenna efficiency, %	55%	55%
Satellite antenna peak gain, dBi	35.3dB	35.3dB
Antenna, noise temp., K	290.0K	290.0K
Feeds,noise temp., K	31.5K	31.5K
LNA,noise temp., K	180.0K	180.0K
Recieving system noise temperature, dBK	**27.dBK**	**27.dBK**
Satellite figure of merit (G/Te), dBi/K	8.3dB/K	8.3dB/K
Pointing error, dB	0.0dB	0.0dB
G/Te, dBi/K	**8.3dB/K**	**8.3dB/K**
C/T @ satellite reciever output, dBW/K	-154.45dBW/K	-163.22dBW/K
1/Boltzmann constant, dBW/K/Hz	228.6dBW/K/Hz	228.6dBW/K/Hz
C/kT @ LNA input, dBHz	**57.1dBHz**	**48.4dBHz**
C/No, dBHz	**57.1dBHz**	**48.4dBHz**
Satellite Transponder Bandwidth, MHz	**10.00MHz**	**10.00MHz**
C/N, dB	**-12.9dB**	**-21.6dB**
Eb/No, dB	**8.8dB**	**0.0dB**
Coding Gain, dB	**4.0dB**	**4.0dB**
Available Eb/No, dB	**12.8dB**	**4.0dB**
BER, 1E-x	**3.85E-10**	**1.25E-02**

Figure 11 Access Control Channel Uplink Budget With 1 Meter User Terminal

	BEAM CENTER, CLEAR SKY	BEAM CENTER, RAIN
	Satellite	
Data rate	**15.500Mbps**	**15.500Mbps**
Modulation type	**QPSK**	**QPSK**
Modulation roll–off response	**0.2**	**0.2**
Code rate	**0.93**	**0.93**
Transmission rate, Mbps	16.667Mbps	16.667Mbps
Required bandwidth, MHz	10.000MHz	10.000MHz
Down-link frequency, GHz	**20.00 GHz**	**20.00 GHz**
Transmitter saturated power rating, W	**30.00W**	**30.00W**
Losses due to multiplexer, filters, couplers, power dividers, ant.	0.5dB	0.5dB
Satellite antenna diameter, m	**0.25m**	**0.25m**
Antenna gain, dBi	31.8dB	31.8dB
EIRP, dBW	**46.1dBW**	**46.1dBW**
	Space to Earth Path	
Altitude, km	35,786.km	35,786 km
Clear-sky free-space path loss, dB	209.5dB	209.5dB
Atmospheric loss, dB	1.1dB	1.1dB
Precipitation loss margin, dB	0.0dB	7.6dB
Down-link losses, dB	**210.6dB**	**218.3dB**
	Earth Station	
Receive earth station antenna diameter, m	**1.00m**	**1.00m**
Antenna efficiency, %	55%	55%
Receiver antenna gain, dBi	43.8dB	43.8dB
Receiving system noise temperature, °K	400.00K	400.00K
Earth station clear-sky figure of merit(G/Ts), dB/K	17.8dB/K	17.8dB/K
Pointing error(satellite motion), dB	0.0dB	0.0dB
G/Te, dBi/K	**17.8dBi/K**	**17.8dBi/K**
C/Td @ earth station reciever output, dBW/K	-146.8dBW/K	-154.4dBW/K
1/Boltzmann constant, dBW/K/Hz	228.6dBW/K/Hz	228.6dBW/K/Hz
C/kTd @ reciever output, dBHz	81.8dBHz	74.2dBHz
C/No, dBHz	**81.8dBHz**	**74.2dBHz**
Transponder bandwidth, MHz	**10.00MHz**	**10.00MHz**
C/N, dB	**11.8dB**	**4.2dB**
Eb/No, dB	**9.6dB**	**2.0dB**
Coding Gain, dB	**4.0dB**	**4.0dB**
Available Eb/No, dB	**13.6dB**	**6.0dB**
BER, 1E-x	**6.68E-12**	**2.50E-03**

Figure 12 Access Control Channel Downlink Budget With 1 Meter User Terminals

The Information Superhighway: Business Opportunity or Invitation to Disaster?

Joan Abramson
ALOHA Networks, Inc.
San Francisco, USA

ABSTRACT

Businesses based upon technology cannot afford to ignore technology. And, more surely than any other industry, in telecommunications marketing and business development must be based on some understanding of the limitations and potential of both existing and new technologies. In the new and competitive telecommunications world we find at the end of the twentieth century the industry requires an understanding of the difference between two one way communication channels and a two way channel. Lack of this understanding in the past has lead to some major accidents on the information superhighway.

Imagine: Being able to send instant email from a remote island in Vanuatu asking for disaster relief following a sudden tidal wave; Returning from a restaurant on Madison and 45th in NYC to find your car has been stolen, reporting it to the police and having them locate it and retrieve it within 20 minutes; Sitting in your living room in North Dakota while your kids monopolize the phone, pushing a few buttons on your TV remote and ordering a movie or a set of $19.95 Ginsu knives.

In the past few years the trade and general press have been full of announcements of new telecommunications products and services that will make just such things possible within a few months or years and at a price that will truly astound us all. The information superhighway has been deemed a reality and it is only a matter of time, we are told, before all of us will be free to join the stream of high speed traffic, and free to do so without the bother of wires, plugs and switches.

In just one small application area alone -- interactive television -- the Baby Bells began 1995 with a series of spectacular announcements: Bell Atlantic promised to link up 1.2 million homes by the end of 1995; Denver based U.S. West promised 600,000 homes would be linked during the same period. Ameritech promised 1 million home links during 1996. (1)

In another area within the past year, billions have been spent by carriers and broadcasters for spectrum to develop nationwide networks to service the wireless, untethered personal communication systems (PCS) that are supposed to provide all of us with low cost, tetherless data transmission -- anywhere, anytime.

So confident have companies become in their ability to deliver these services -- or perhaps so anxious to remain ahead of their competitors -- that even announcements of new computer and communications devices, software and services have taken on the trappings once reserved for Hollywood premiers. The recent multi-million dollar introduction of Windows 95 is one such example. Microsoft's use of Mick Jagger's song, "Start Me Up" was so successful many people probably associate the song exclusively with Windows 95 rather than with the Rolling Stones.

Even small technology companies now take to the stage routinely for the purpose of making product announcements. Take, for example, the following excerpt from Jerry Kaplan's book, Startup. (2)

> Carol gave the signal to open the doors, and seven hundred invited guests flowed into the ballroom. The transformation from the previous evening was dramatic -- everything was orderly, polished, and clean. The rehearsals began at three, and I was up first. The director showed me my mark and video cue, then motioned me to the podium. . .
>
> The next morning, I drove back to the hotel. I knew that within a few hours, either we would be the laughingstock of the computer industry -- having blown $25 million in a foolhardy attempt to convince people that pen computers were something new and different -- or we would be hailed as visionaries. I still did not know which way this $500,000 show was going to go. . .

Interestingly enough, in this case the hype had no substance: GO's half million dollar product announcement was not accompanied by a working product. And $50 million, but less than two years later, the company folded, without ever producing the promised pen based computer or operating software.

Go is, in a way, the quintessential high tech cautionary tale. And the moral of that tale is clear: A business based upon technology cannot afford to ignore that technology.

In telecommunications, more surely, perhaps, than in any other industry, the recognition of technological possibilities and limitations -- as well as the failure to recognize the business impact of new technological possibilities -- has proven time and again to be the key to the success or failure of new business ventures.

This may seem to be stating the obvious. Surely people involved in businesses based on leading edge, rapidly changing technology must know that they must keep on top of that technology. Unfortunately this is not always the case.

The press is full of stories of companies that have heeded the lessons of telecommunications technology, and profited. In the 1970s, for example, Ted Turner, staring out as the owner of a local Atlanta television station, had an idea that took advantage of a new technological resource. His idea grew into a huge new industry -- the satellite distribution of national television services to cable outlets -- and less than 20 years later, Turner Broadcasting was sold to Time Warner Inc. for $7.5 billion. Turner's personal share was $2.6 billion plus a couple of other things, like $15 M a year for 5 years. Not a bad return for an idea that many people laughed at in the beginning. And in the interim, he revolutionized the entire business of news delivery and brought the information age into living rooms around the world.

More recently, we have examples like Netscape, which began two years ago when Jim Clark , looking around for a business opportunity, searched out the creator of Mosaic -- a university developed Internet browser. From this relatively modest start he created a commercial Internet browser and a head spinning Wall Street success story with a value, at its initial public offering, of a record breaking $2.4 Billion.

But, unfortunately, the press is also full of stories of companies that failed to heed the lesson -- companies that, for lack of attention to technologies that were at the heart of their business concepts -- either attempted to market a concept before the technology was available or, equally devastating, gambled on outmoded, outclassed technical concepts.

How many people, for example, remember SBS? SBS started with a good idea: to provide satellite communication service including voice, video and data to single companies, directly to the "customer premises". Moreover, SBS started out with company and capital backing that seemed, at first, to almost guarantee its success. The new corporation began its life as a giant, partly owned by COMSAT, which provided satellite expertise, by IBM Corporation during its heyday as the only major competitor in the computer business and by Aetna Insurance, one of the largest insurance companies in the country and a ready made first customer for the new venture. But within 8 years, the company had folded with a spectacular loss of over $1 billion. (3)

What happened?

Of course, a number of business reasons were offered during the post mortem period. But the reason of interest here is the technology. And it is clear that SBS was based upon a business concept that was a mismatch to available technology. That key idea -- to provide customer premise satellite links -- was impossible to realize with the TDMA technology chosen by IBM in 1981. The company goal of providing private earth stations to individual businesses could not be achieved. at a price that could attract even a few customers. SBS ended up having to market earth stations as shared, not private facilities. And rather than being described as a visionary venture, SBS rapidly became known as a company based on "a technology that doesn't work for a market that doesn't exist."

SBS was not the only example. The recent history of two way telecommunications products is littered with expensive failures. How many people, for example, remember videotex? Among the early versions of this product was Viewtron, jointly owned by Knight-Ridder and Times Mirror, and advertised in the late 1970s and early 1980s as "what you want when you want it." By the time Viewtron's joint venture with AT & T came to an end in 1986, over $150 million had been lost and the videotex technology had earned a reputation as "the lemon in the living room." (4)

And what about the videophone, which seems to comes back to haunt more than once in every decade? The first videophone was introduced by AT & T with great fanfare at the 1964 World's Fair. It was a resounding flop. The latest free-standing version, called the Video Phone 2500 and priced at $1,500 was introduced by AT & T in 1992, with equally disastrous results. Nevertheless, the company continues to pursue two versions of the idea -- a video conferencing version using PC based technology and yet another version of the free standing videophone, which AT & T plans to introduce, in cooperation with Hitachi and Sharp, during the second half of this year. (5)

A last, more recent example is the pen based computer first conceptualized by the small group of entrepreneurs who founded GO Corporation in 1987. By 1993, writes CEO Jerry Kaplan, "GO was gone. Six years, hundreds of jobs, $75 million -- all gone." (2) So, what went wrong?

In a candid moment, Kaplan admits that in five years of development work, Go was never able to come up with a product. From the beginning, the company lacked a clear idea of what it was producing. It started out with the idea of turning out both the software and hardware for pen based computers. Somewhere along the line, with hardly a nod from anyone inside the company, the hardware seems to have faded out of the picture and software for other people's pen computer hardware became the company focus. Then the software grew -- as it often does -- and in the end well over 100 software engineers were writing enormous volumes of code but falling short of an actual, operating system. And all along, one gets the impression that an actual product was the vaguest, least important part of the whole corporate culture.

But there is also a more subtle answer that pervades all 300 pages of Kaplan's book: The founders of GO did not understand the limitations of the technology needed to turn their concept into a reality. This is particularly clear in telecommunications.

> We will use (pen computers) to take notes; send and receive messages through cellular telephone links; look up addresses, phone numbers, price lists, and inventories; do spreadsheet calculations, and fill out order

> forms. . . . Like the fax machine, the pen computer can dramatically accelerate the pace and increase the efficiency at which business can be conducted.

Similar thinking appears again and again, throughout the book: "You could transmit a record of a trade immediately, through a wireless link," "the mother of all markets created by the convergence of computers and communications," "a new class of devices. . . combining the functions of pen computers and mobile telephones," "personal communicator strategy. . .a fax could be received through a wireless cellular connection," "at every opportunity I wove a tale about the personal communicator as the successor to the cellular phone," "with the personal communicator of the future, we will address people, not machines, wherever they happen to be."

This sales and marketing strategy -- essentially touting a mobile, tetherless communication system -- was apparently based on no idea whatever of the nature of two way telecommunications technology, its possibilities, or its limitations. GO had no shortage of bright people, and no shortage of backers with deep pockets. But all of them, founders and investors alike, seem to have believed that all that was required was to build a pen based notebook computer and somehow, the thing would be able to commune with all other pen based computers, no matter where they were, plugged, unplugged, stationary or traveling.

Given this kind of thinking, it is not hard to imagine spending $75 million over less than six years and never coming close to having an operating product -- either hardware or software.

The only real wonder, in the story of GO Computers or SBS or Videotron, or any of the other technological crashes that litter the information superhighway, is that these ideas could get any funding in the first place. Or that during the process of developing their business concept, it appears that not one single cautionary voice was raised, not one single question asked about the ability of the business to deliver.

Of course, we now know that many of these visionary ideas are not only possible but have become a reality -- albeit with some limitations. Videotex has come back in a new form as the data services provided by Prodigy, America Online and Compuserve. Private data networks are a growing segment of the telecommunications market since the advent of two way VSATs. Even pen based computers, tied to PC modems, may become a modest marketplace success story.

Were these failures, then, simply a matter of businesses getting too far ahead of their time? Perhaps. In some respects it is indeed true that timing is everything. Designing a business well ahead of the technology required to make that business viable -- even when founders have clear vision of that future technology -- is a risk. Even, perhaps, a recipe for failure since it practically guarantees that products will be expensive and flawed.

But it is equally true that designing a business that falls behind the available technology can be just as risky. Interactive television is an example: The well hyped announcements by the Baby Bells, made just one or two years ago, would have us believe that by now millions of American homes would be tied in to two way television services.

But by July, 1995, a lead article in the Wall Street Journal focused on "overpromising" by the Baby Bells. Bell Atlantic, the Journal said, "so far...doesn't have a single commercial customer. U.S. West. . . has only 135 homes in a trial, and none get interactive fare. Pacific Telesis Group is running a year or more behind schedule in California. Ameritech Corp. is also lagging, slashing its one-million-home target for 1996 to 200,000 and aiming to deliver only regular cable services at first." (1)

Two months later the Journal reported that Pacific Telesis was "scaling back its plans to build interactive video networks throughout California," and was planning to begin investigating wireless cable. (6)

The promise of two way, interactive video services has been hollow. The reason, say the operators, is the lack of an appropriate technology: a technology that can handle the load at an acceptable level of cost and simplicity.

Another example is PCS. The FCC auctions of Personal Computer Service broadband spectrum brought $7.7 billion to U.S. government coffers. (7) Dozens of companies, large and small, made the investments with the intention of establishing their presence in what the FCC-- and the industry -- sees as a major and lucrative new PCS market.

But what do these companies have to offer the public now that they have made the initial investment? And what can they tell their investors about the timetable for realizing a profit? Moreover, what can they tell the FCC about how they intend to fulfill the promise of providing PCS service to the nation?

The press in recent years has been the forum for a continuing debate over whether CDMA or TDMA will be the technology of choice for use in a national microcellular PCS network. About a year ago, much of the debate was focused on the probable choice of TDMA . In recent months the pendulum has swung in the other direction with several large consortia announcing that they intend to adapt a version of the IS 95 CDMA standard introduced by Qualcomm. (8) The reports were followed by an upsurge in the value of Qualcomm stock to 54 1/4 in mid August, 1995, more than double its value of a year earlier.

But in the debate over these two technologies, one thing has been overlooked: PCS was supposed to offer something more than voice service. It was supposed to offer a wide variety of data services in a microcellular structure, not just another network for wireless voice service in a different frequency band. Yet neither TDMA nor CDMA is well adopted to providing transaction oriented data traffic.

What is being announced by the new spectrum owners is, in fact, nothing more than yet another voice service, this one provided through microcellular rather than cellular connections. In fact, if microcellular service providers do use these technologies, any non-voice, transaction data service they may attempt to offer will certainly be at such a high price, and with such limited ability to service end users, that it will neither meet the PCS expectations of the FCC nor realize a profit for investors.

The rush to offer services that can do little more than cellular voice systems is understandable: the winning bidders in the spectrum auctions spent billions. They are looking for a quick way to turn a profit for investors. However, the penalty for such limited service can be high. With voice service as their major offering, the microcellular networks will compete directly with the current cellular networks. Both services may suffer the competitive pricing consequences in a market that already finds itself giving away phones to stimulate subscriptions.

The satellite area provides yet another example: Over the past few years, a number of companies have announced new low earth orbiting satellite systems that are supposed to bring us a wide range of mixed telecommunications services for voice, video, transaction data traffic and file traffic. Most of these systems have been, at best, slow to develop. And two -- Globalstar and Iridium -- have recently had to withdraw the junk bond offerings they had hoped would finance their systems. (9)

Investors, it seems, cannot fathom the benefits of either system and cannot determine which technologies will succeed. Is it any wonder? In fact, both systems are making few precise claims about the kinds of traffic they will be able to handle. And investors may well wonder why they should put

938

money into systems that cannot offer more than another kind of cellular service plus a limited amount of "light" data service.

One may well ask, "What is the Problem?"

Why have there been so many optimistic and futuristic announcements of two way global tetherless communications products and so few actual products? Why have so many product and service announcements been followed by embarrassing backpedaling? And why have so many of the products that actually make it to market (the recent MTEL two way pager for example) been so disappointingly limited in performance?

The answer -- and the point of this paper -- is simple: New high technology products must be based on an up to date understanding of the technology. They cannot successfully enter the marketplace before the technology upon which they are based in reliable and cost effective. Nor can they compete if the technology upon which they are based has been bypassed by more efficient, more cost effective technologies.

This may seem simple and obvious. Yet the history of new, commercial telecommunications ventures is littered with the corpses of companies that have not understood this fundamental and simple truth.

The dream of an age where ubiquitous, wireless voice, data and video service is a commonplace commodity, available anytime, anyplace, at a price that can make it universally available has been voiced again and again in product announcements and in the plans of service providers. But plans have been delayed or canceled again and again and the pundits of gloom have repeatedly insisted that the technology that can make the dream possible does not yet exist. "It's like going to the moon," according to one such pundit, . ."None of us realized the complexity" of building interactive networks." (1)

Indeed, this is the heart of the problem: Business planners and engineers alike have all too often failed to recognize that two-way, interactive communication is not simply two one-way communication systems put together. And in failing to recognize the complexity of two way links, some of these planners have overlooked the fact that the technology that can make this dream come true does exist. It is the next generation technology to the only currently available, commercially viable two way wireless multiple access technology for transaction traffic. That current generation technology was created right here in Hawaii. It is called ALOHA.

First generation ALOHA technology has been available since the early 1970s. It is the basis for all Ethernet protocols and it is currently used throughout the two-way communications industry, including INMARSAT satellites, a number of low and medium capacity systems such as Mtel's two way paging system, the Ardis and Ericsson Ram Mobile Data networks in the US, the Teleterminal network in Japan, the request channel of the Qualcomm I-95 CDMA cellular voice standard and more than 100,000 very small aperture earth stations (VSAT's) now in operation.

But first generation ALOHA is a narrowband technology, and today the communication service and product industry is interested in markets that can reach tens of thousands or tens of millions of users. Narrowband systems, even if they are offered in multiples, cannot service such large numbers or provide the simplicity, flexibility, low cost or reliability of well designed broadband systems.

It is in this vast and largely unserviced and unexploited market area that second generation, Spread ALOHA is beginning to play a major enabling role. Simply put, any telecommunication product or service provider planning to enter the competition for broadband, wireless customers would do well to look at this new ALOHA Networks, Inc. technology. This is true regardless of the delivery method -- whether it is through satellite, microcellular, or cellular systems. And it is true regardless of the application planned -- whether it is PCS, personal digital assistants, sensor networks, inventory control, merchant credit checking, transaction traffic, file traffic, voice and data mixed use networks, interactive video, or wireless local and wide area networks.

ALOHA technology is proven technology and is the only currently available, commercially viable wireless technology for transaction traffic in narrowband systems. Spread ALOHA offers the same proven technology for broadband systems that can service millions of users cheaply and reliably.

Any company whose business it is to provide leading edge telecommunications services cannot afford to ignore the technology which makes those services possible. Companies that do so risk being left in the dust with little to offer their investors or their customers but broken promises.

The telecommunications world is moving rapidly. New markets are opening up on an almost daily basis. And new companies offering a vast array of new products and services are entering the competition for markets just as rapidly.

If these companies are to compete successfully -- and survive -- in today's rapidly moving telecommunications industry it is essential that they maintain an awareness of the technology, its limitations and its possibilities. To remain oblivious is to court failure. To keep aware, on the other hand, can open up incredible business opportunities that will provide remarkable services to the public at a price that can rapidly bring the whole world into the information age, while bringing investors a spectacular return on investment.

References:

(1) Leslie Cauley "Phone Giants Discover The Interactive Path is Full of Obstacles", *The Wall Street Journal*, July 24, 1995.

(2) Kaplan, Jerry, Startup, Houghton Mifflin, Boston, 1995.

(3) "SBS Reporting Continuing Losses", *Telecommunications Reports*, May 7, 1984.

(4) Ralph T. King Jr. "No, Thanks: The history of home technology is littered with flops." *The Wall Street Journal*, June 19, 1995

(5) Bart Ziegler. "Seeing Isn't Believing: The videophone keeps failing -- and it keeps coming back." *The Wall Street Journal*, June 19, 1995

(6) Leslie Cauley, "PacTel Puts Off Interactive-Video Plans, Concentrating Instead on Wireless Cable." *The Wall Street Journal*, September 28, 1995.

(7) "Cellular Phones: Short circuited." *The Economist*, July 29, 1995.

(8) W. Wayt Gibbs. "When Cells Divide: Making space for the next wave of wireless communications." *Scientific American*, December, 1993. Larry Armstrong. "Unproven But Dazzling: Qualcomm is on a roll with its cell-phone technology". *Business Week*, September 4, 1995.

(9) Jeff Coll. "Star Wars: In New Space Race, Companies Are Seeking Dollars From Heaven." *The Wall Street Journal*, October 10, 1995.

The Information Infrastructure: Opportunities and Decisions

by John Spence
John A. Spence & Associates
Sydney, Australia

1. ABSTRACT

New developments now help countries and companies to make successful choices between today's huge range of telecommunications and convergence options. The task of deciding what to do and when is enormous, and growing. Predicted changes in technology and markets offer great opportunities for users and providers. But, with today's range of technology, they also represent a vast array of alternatives - with varying capabilities and risks. That means hard decisions on how best to develop country and corporate infrastructures. This paper explores how new advances in Decision Analysis are benefiting management in these environments.

2. DYNAMICS REQUIRE NEW DECISION APPROACHES

Telecommunications is a rapidly changing environment filled with uncertainties about the demand for services, the nature of competition, and future technological developments. In the face of these uncertainties, alternative strategies are having to be evaluated, and new directions decided, very carefully - by users and providers, by companies and countries.

Making the right decision has always been difficult, especially in this dynamic world, with its accelerating technologies, largely unpredictable future and diversity of needs. Indeed, telecommunications is constantly developing exciting new options for users and providers, enlarging the already vast array of choices. So new means are needed to help ensure better decisions from among them.

3. THE DECISION-MAKER'S MANY ALTERNATIVES

This sea of alternatives includes first the choice of how much of the customers' or community's changing needs to satisfy. What was earlier a demand for voice service now often extends to an increasing requirement for data. Video is also hard upon us, with pressure growing for more video-conferencing and visual person-to-person communications. Moreover, multimedia and interactive services have already captured people's attention and soon will be a significant part of the demand profile of companies, customers and communities.

Next, and very importantly in any developing company or country, there are such key decisions as whether to upgrade or replace existing systems, how to anticipate and plan for the uncertain future, whether and how to trade off costs for performance, and how to balance all those factors against the resulting technical complexities and the management skills they will require. These are especially critical where key resources are in short supply.

Then there is the spectrum of delivery options. The briefest of lists of what to consider includes cable (copper and fibre), satellite services (with their diversity of transmitting bands and multiplicity of footprints), microwave and other developing radio platforms, together with now, very significantly, cellular, which has already demonstrated its potential to accelerate telecommunications infrastructure where the established facilities are limited.

Furthermore, for the telecommunications networks themselves, in addition to the decisions between different sites and routes, there is also seemingly an endless range of equipment alternatives to choose from - with different types, designs, capabilities, suppliers and costs.

Clearly not all these alternatives come into play in any particular decision. But a large number of them feature surprisingly often - representing complex decision scenarios, with no easy answers as to the best courses of action. Moreover until recently, proposals placed before managements and governments to effectively address telecommunications needs have often presented only limited estimates of costs and performance. They have seldom provided the practical alternatives along with their implications and uncertainties - and the means to compare them - which the decision-maker needs to make the correct choices.

But the situation has changed. There are now potent means available for handling these multiple-choice situations, using computerised modelling.

4. NEW PATHS TO BETTER DECISIONS

From the very beginning, mathematically oriented approaches have been applied in telecommunications. Queueing methods have been used to represent (or model) traffic behaviour and determine the capacities required on communications networks. As the networks have grown in size, other modelling approaches - like those developed for the complex task of optimising sequences - have been used for routing calls and designing the most cost-effective and reliable arrangements of switches and interconnections from amongst the enormous range of alternatives.

The recent contributions to the decision-making area have been to link optimising approaches with "Decision Analysis" methodology in ways which now mean large scale decisions can be handled more easily and reliably.

Decision Analysis (DA) on its own has been around a long time - being, as its name implies, a systematic means of treating decision processes. However, it has generally been hard to apply because of the time and tedium associated with preparing and altering the "decision trees" which describe the areas of choice. Optimisation has also been practised widely since the fifties. But it too has been limited in the complexity and size of problem it could address without access to massive computer power. The breakthrough has come with advances in software and hardware making solutions possible, easy to comprehend, and nowadays within the range of personal computers.

5. WHERE IS THIS APPLIED ?

Decisions in the telecommunications related world can take many different and varied forms. For example in the information services market a leading manufacturer of voice mail used these approaches to choose between different products and directions in the face of a series of competitive and other uncertainties. Essentially it used DA to help formulate its business strategy, based on the analysis of the expected gains and key risks associated with each available alternative.

Another organisation used these approaches in decisions on how to allocate R&D expenditure, build manufacturing capacity, set pricing strategies, and identify appropriate product configurations for target markets. This was based on a model of technological substitution in this market. The model was designed to reflect the market's perception of new technologies and critical issues like standards, legal factors, technology maturity, and the presence of key vendors like IBM.

Other logical applications involve decisions on how countries and companies can grow their communications infrastructures to best meet the developing needs of their communities and customers, given the multiplicity of choices available to them. These include all the options ranging from system upgrade to replacement; the many competing technical configurations which could meet requirements; the cost alternatives; the uncertainties associated with supplier and system reliability, with installation timing plus market and competitor response; the resources needed; and the cost and performance objectives to be satisfied. The outputs show the "best" strategies together with the risks and benefits associated with alternative courses of action.

6. OUTLINE OF THE APPROACH

The starting point for this process is to set down the factors involved in any decision involving many choices, using different shaped symbols to distinguish between Decisions, Influences and Outcomes. As an example, the DECISION may be whether or not to launch a particular information services product. The UNCERTAINTY could be the sales level, including the impact of competition. The OUTCOMES are then typically the revenues, costs and some measure of success like profit or market penetration following the decision and the uncertainty.

A simple representation of this is shown diagrammatically below in Figure 1 in the form of an "Influence Diagram" with the basic elements represented respectively by a rectangle, an ellipse and rectangles with rounded corners, with interconnecting arrows defining relationships.

Fig.1: Basic Influence Diagram

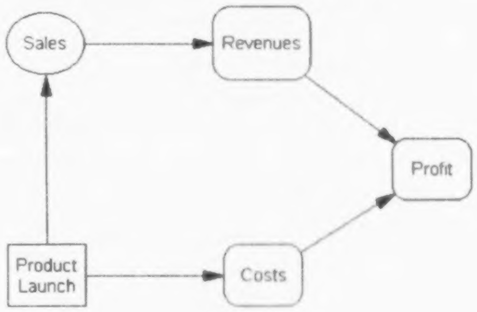
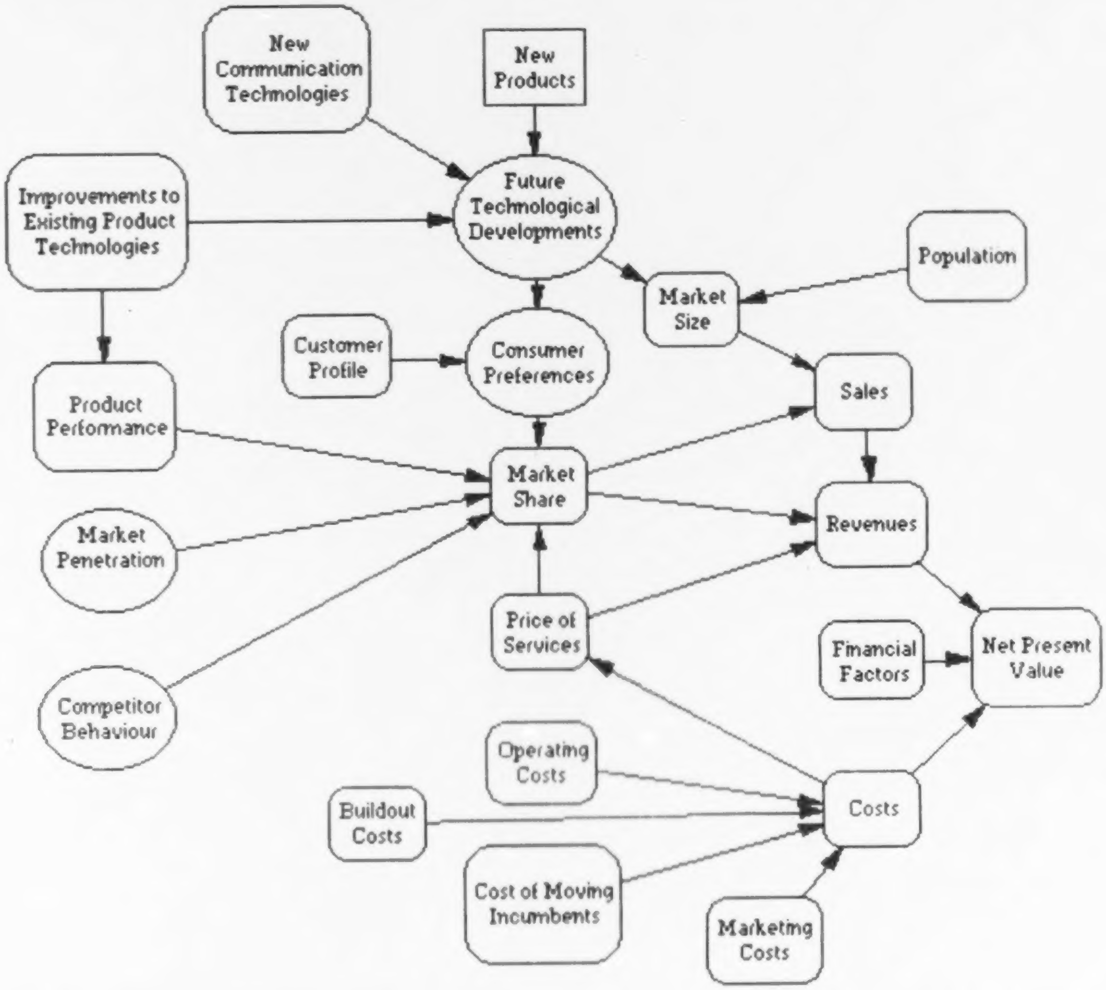


Fig. 2: Telecommunications Licence Decision


New Communication Technologies
New Products
Improvements to Existing Product Technologies
Future Technological Developments
Population
Market Size
Customer Profile
Consumer Preferences
Product Performance
Sales
Market Share
Revenues
Market Penetration
Price of Services
Financial Factors
Net Present Value
Competitor Behaviour
Operating Costs
Buildout Costs
Costs
Cost of Moving Incumbents
Marketing Costs

This simple decision process quickly grows in complexity when the relevant products, costs, market response forecasts and competitive features are added. As all the important realistic influences, uncertainties and interrelationships are then introduced, the diagram escalates in size and interaction, as indicated in Figure 2.

This diagram reflects the decision issues facing a major provider of telephone, cellular and paging services which was competing in auctions for personal communications services (PCS) licences. The licences were designed to allow owners to operate wireless services within a designated bandwidth in a given geographical region. The approach taken was to develop a decision model to evaluate licences in the various geographical areas and so guide their bidding at the auctions.

The three strategies being considered were landline, cellular and PCS. The key uncertainties included price and performance for these strategies, the wireless market penetration, and both the roll-out and marketing costs. The model was used successfully to examine the likely response of different market segments to different scenarios of service and product offerings.

7. HOW DOES DA DIFFER ?

What is different about the Decision Analysis approach? Most analytical approaches - including optimisation - show the best or most expected result. The main difference with DA is its ability to show not only that result but also the alternatives, together with the impacts that any changes and uncertainties would have on decision outcomes.

This can perhaps be best covered by the actual example of an organisation deciding which action to take to upgrade its system to meet market growth and changing customer requirements. The decisions revolved around which system to adopt. The uncertainties included the size and expectations of the market, competitor action, the likely rate of technological obsolescence, and the costs of the different choices. Several outcomes were of interest; but overall performance and profitability were paramount.

To illustrate this process, an abbreviated influence diagram for this organisation's position is shown in Figure 3.

The situation involved three choices of improved service, with significantly increased market acceptance for the most expensive option which also necessitated investment in added facilities. The relevant costs and probabilities were processed with appropriate DA software to determine the "best" course to follow - which turned out to be to invest in the most costly option (which would generate a net return of $24 million compared to $18 million for the next best). But this was a result to be treated with caution.

As mentioned earlier, the particular value of DA is that, through a series of tests and supporting diagrams, it is now possible to identify the extent to which changes in the estimates or expectations could alter the expected outcomes and hence greatly affect management's decisions.

This property is indicated in Figure 4 which, in a Risk Profile Diagram, highlights that even the optimal policy had risks attached. While $24 million might have been expected value, all the uncertainties were found to cause the possible outcomes to range from losing about $40 million to making around $200 million.

Fig. 3 Decisions on Upgrading Facilities

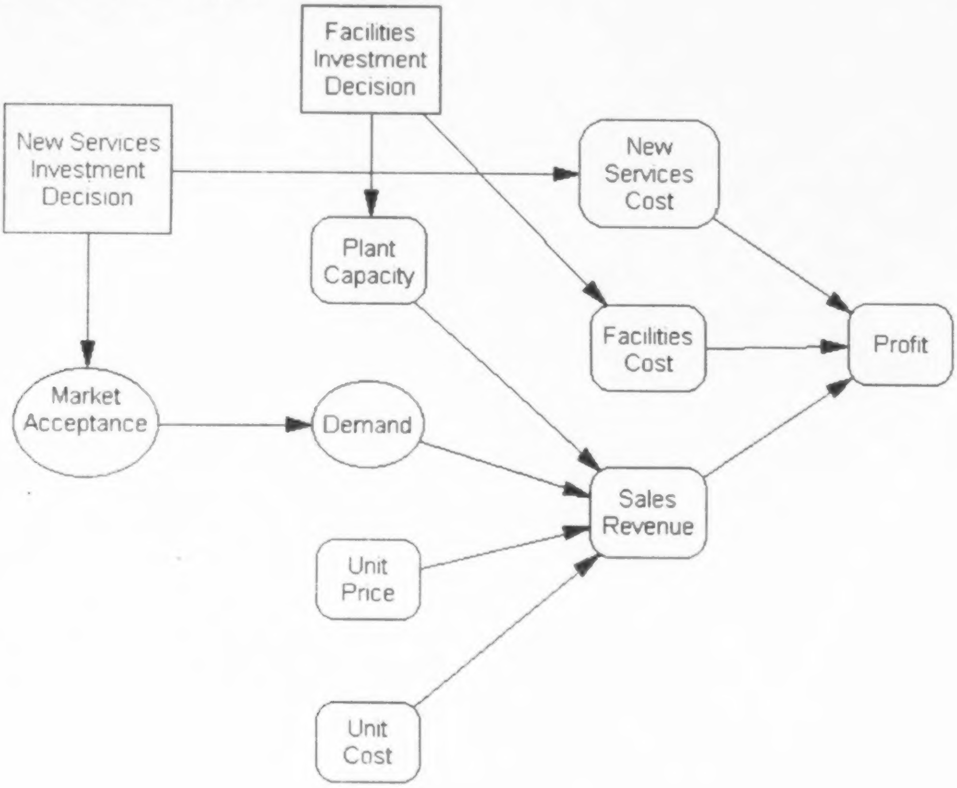
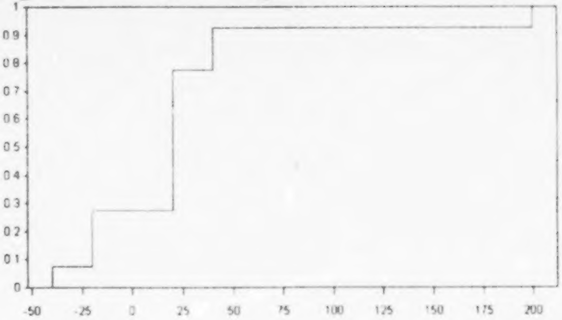


Fig. 4: Risk Profile Diagram

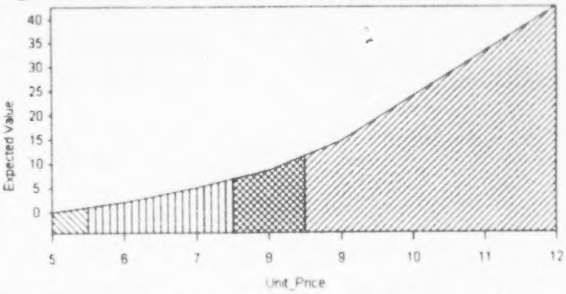


The right decision for any organisation given a picture like this clearly depends on management's own risk profile - on how innovative or risk averse they are.

This matter of the attitude of an organisation or government to risk is seldom appreciated but is fundamental in the decision process, leading to very different decisions. And risk profiles vary considerably. So there is great value for management in being able to quantify the risks as well as the likely returns associated with different decisions or strategies in this way.

Other key insights can be gained from Rainbow Diagrams which highlight the outcomes under different situations and, therefore, indicate when strategies should be changed as circumstances alter. This is illustrated in Figure 5 for the same organisation.

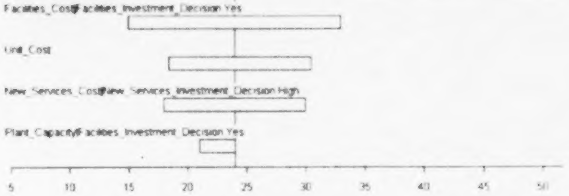
Fig. 5: Rainbow Diagram Shows Changes



In this instance the plot showed how the profit would change as the unit price was altered. This was run to reflect a range of expected profit from $0 to over $40 million. The changes in the hatching indicate where changes in policy or strategy should be made. And this diagram showed that the optimal policy would change as the unit price was varied. It can be seen that the changes occur between $5 and $6, between $7 and $8 , and between $8 and $9 per unit.

A further example of DA's offerings is shown in Figure 6 which is known as a "tornado diagram" - named for the tapering shape of the range bars. These vary from those having the greatest impact at the top to those with least at the bottom. These diagrams are most effective in focussing attention on the significant decision influences - and away from those factors which often worry but are unimportant.

Fig. 6: Tornado Diagram Shows Significance



In this case it brings out that the key elements in the decision were the price and, to a lesser extent the cost of the added facilities to be built. The unit cost and levels of investment in the new services were less important, while variations in plant capacity were seen to be of least significance.

8. DECISION ANALYSIS DIRECTIONS

In combination these diagrams with varied data inputs give the decision maker a comprehensive picture of the implications of the different choices. They show the options, the risks, the changes in direction as elements like price are varied, and the key factors influencing the outcome. Moreover they enable individuals, companies and governments to choose directions having risk and result levels with which they are compatible.

Frequently these approaches are integrated with optimisation techniques so that best "economic" solutions have the necessary accompaniment of uncertainties in data, performance and the environment, whatever form that may take. Just as often DA is used alone to resolve important areas of policy, strategy and tactics.

As regards the best areas of application, telecommunications is an ideal field given the wide spectrum of environments and means to satisfy them. But the approach is effective in all decision areas.

9. VITAL TOOL FOR MANAGEMENTS IN TELECOMMUNICATIONS

In summary, new Decision Analysis approaches offer the decision maker, however non-technical or technical, the means to make more informed and better decisions between the many courses of action. The options can be clearly defined, quantified and visually presented so that the significance of influencing factors can be readily comprehended.

The result is that management can focus on the critical issues - usually relatively few - by identifying and ignoring the irrelevant which can be serious distractions.

The best answers for managements have always been to keep options open rather than be committed to single courses of action. But the engineered proposals of the past have frequently been focused on limited scenarios and objectives, offering only room for yes-or-no responses.

With Decision Analysis the scene has shifted significantly. All the key elements and uncertainties in the decision can now be presented, varied and analysed in depth. This is a powerful means to assist developing and developed areas and companies alike to advance their infrastructure and build their success in this dynamic field of telecommunications and convergence.

Videoconferencing Using VSAT

Dave Rehbehn
Hughes Network Systems, Inc.
Germantown, MD U.S.A.

ABSTRACT

The demand for videoconferencing capabilities has increased dramatically over the last several years. This demand has been fueled by a number of factors, including increased affordability of videoconference systems, improved technology, and the desire to achieve more effective communications at a lower cost. In developing areas this demand has traditionally been constrained by the lack of adequate communications infrastructure that can accommodate videoconferencing. A good solution to overcome these limitations is the use of satellite communications. This paper focuses on the solutions for videoconferencing that can be achieved using very small aperture terminals (VSATs) over satellite. This paper provides an overview of videoconferencing solutions using VSAT systems. Of particular focus is the solution for multipoint videoconference where more than two remote sites will actively participate, i.e., transmission of a video signal. This paper does not focus on the video equipment itself - only on the transmission equipment.

CONFERENCE ROOM BASED SYSTEMS

There are two main classes of videoconferencing systems: *desktop-based* systems and *conference room-based* systems. Each class is best suited for different applications and the two are not truly interchangeable. The focus of this paper is on conference room–based systems.

Conference room–based systems are intended for the use of several participants at each site in respective conference rooms conducting a joint meeting. For such group meetings there is sufficient movement to warrant rates of 128 kbps, 256 kbps, 384 kbps, or higher to achieve the desired video quality. Full duplex video and audio is also provided. Conference room–based systems include at least one video monitor, one camera, a codec, microphones, and multiple speakers per site.

VIDEOCONFERENCE CONFIGURATIONS

Before a close examination is made of the solutions possible, it is useful to review the different modes or configurations that are commonly used in videoconferencing.

Broadcast - One site can transmit video and audio to any number of remote sites. The remote sites are configured with an antenna, low noise block (LNB) converter, integrated satellite receiver and decoder (IRD), and TV or VCR. Remote sites do not have any communication possibility back to the transmission station. Broadcast is commonly used for business TV applications such as training and communicating corporate messages to remote staff. **Figure 1** illustrates a broadcast conference.

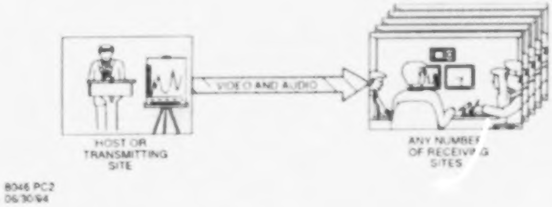
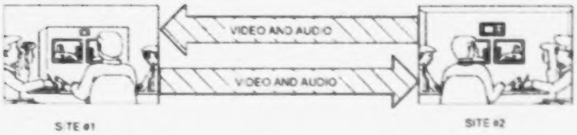


FIGURE 1. BROADCAST CONFERENCES

Broadcast with return audio/data - This configuration is gaining popularity for distance learning a applications. In addition to the equipment required for the broadcast configuration, there is also a return path that allows the transmission of voice and data back to the central site, which allows the participants in the remote locations to ask questions or be queried directly from the central site.

Point to Point - Any two sites in the network can participate in a fully interactive videoconference. These two sites communicate directly with each other and with no one else. **Figure 2** illustrates the configuration for a two-site point-to-point conference.



NOTE:
(1) SITES HOLD A FULLY INTERACTIVE VIDEOCONFERENCE

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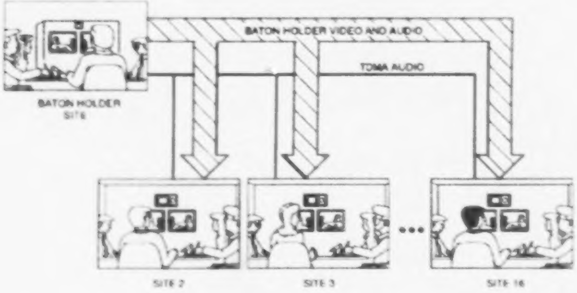
FIGURE 2. POINT TO POINT

Multipoint (N-Way) - Up to N sites can hold a videoconference in which one site is the host (it transmits the video), while the other sites transmit audio. Throughout the conference, all sites hear all other sites. This configuration is illustrated in **Figure 3**.



NOTES:
(1) HOST SITE TRANSMITS VIDEO AND AUDIO TO ALL SITES IN CONFERENCE
(2) SITES 2 TO 16 MAY BECOME THE BATON HOLDER SITE
(3) ALL LOCATIONS RECEIVE BRIDGED AUDIO FROM ALL OTHER SITES

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FIGURE 3. N-WAY CONFERENCE

Both of the broadcast modes are uniquely suited for satellite transmission, as the establishment of multiple circuits (one for each station to receive the signal) over a terrestrial system would be impractical and costly. Additionally, the broadcast modes typically require very high motion and sharpness with regard to picture quality and require high amounts of bandwidth (more than 1 Mbps). The architecture that satisfies these modes is quite simple and this paper will focus only on the solutions for interactive point-to-point and multipoint videoconferencing.

SATELLITE VS. TERRESTRIAL VIDEOCONFERENCING

Prior to examining the solutions for satellite-based interactive videoconferencing, it is worthwhile to conduct a tradeoff of terrestrial-based solutions against satellite-based solutions.

Videoconferencing networks can be implemented using one of two transmission technologies: satellite or terrestrial. In order to compare the two, the following four areas have been identified as the most important factors in choosing a transmission medium for videoconferencing:

- Coverage - service where needed
- Reliability - service when needed
- Economy - cost-effective service
- Ease of Use - efficient network management

Each technology is capable of supporting several different types of conference. In order to effectively compare the competing transmission media, we will look at broadcast, point-to-point, and multipoint operation. It is important to note that multipoint conferencing is the conveyance of audio and video information among multiple sites with the capability of interaction between sites. It is in the implementation of multipoint conferencing that significant differences emerge between satellite and terrestrial transmission.

Coverage

Terrestrial communications technology depends completely upon the preexistence of a terrestrial communications infrastructure: copper wire, fiber optic cable, point-to-point radio, cellular radio, etc. Implementation of a video teleconference network using terrestrial technology further requires the preexistence of high speed versions of the infrastructure elements listed above. This dependence is a problem in many rural areas.

Satellite coverage is available virtually everywhere. There is no dependence on any preexisting infrastructure, and there are very few requirements for equipment facilities.

Reliability

Communication from point A to point B over long distances using terrestrial technology must, of necessity, involve multiple transmission media, connected by multiple switching elements, operating in multiple political jurisdictions. Add to this the multiplying factor induced by multipoint conferences, and the number of potential sources of interruption increases rapidly. In the event of an interruption in service, the problem could lie anywhere in a variety of transmission networks.

In a satellite-based network, the entire service is provided by a single entity, thereby minimizing the number of potential failures and providing full visibility of the end-to-end network.

Economy

In a terrestrial environment, multipoint conferences consume transmission media in amounts proportional to the number of sites participating and to the length of the conference. This factor results in transmission medium usage costs that rise as the size and duration of the multipoint conference increases; i.e., the variable recurring costs dominate the financial analysis.

In a satellite-based network the variable recurring costs are zero; i.e., the transmission medium consumed by a multipoint conference is constant, not a function of the number of sites participating in the conference. Therefore, the recurring costs incurred do not increase as the size of the conference grows.

Ease of Use

In order to set up a multipoint videoconference in a terrestrial environment, it is necessary to arrange for a transmission path from each participating site to a central location (hub). This path will involve all of the terrestrial communications elements listed above, and a separate path is required for each site. Each path will involve local telephone companies and, in most cases, long distance carriers. Further, a switching element is required at the hub, and it must be programmed as a part of the conference setup process.

In a satellite-based videoconferencing network it is possible to use the inherent broadcast capabilities of satellite to minimize the number of transmission paths required for the application.

VSAT SYSTEMS ACCESS ARCHITECTURES

VSATs have gained widespread acceptance for a variety of communications solutions. The general characteristics of VSATs include an integrated electronics package with a small (less than 2.4 meter diameter) antenna and low cost. Within this broad definition there exist several different satellite access architectures.

The most basic distinction between VSAT architectures is whether the satellite channel capacity is dedicated to one user or whether multiple users are multiplexed together over the common resource. A clear channel circuit-based system will allocate a full duplex circuit from one point of the network to another point of the network. In this environment the satellite network will transmit every data bit received from one end to the far end in the exact order received. The output of data bits at the far end matches exactly the input of data bits at the origination. Thus, a 64 kbps interface will consume 64 kbps of satellite bandwidth. **Figure 4** illustrates how a clear channel circuit-based resource is utilized.

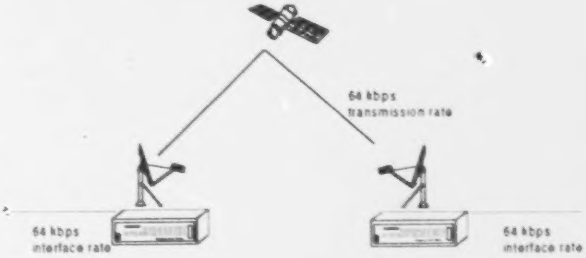

FIGURE 4. CIRCUIT ACCESS

Circuit-based systems are well suited economically for voice channels but can also support data channels. Circuit-based architectures are well suited for mesh topologies and can use preassigned single channel per carrier (SCPC), demand assigned multiple access (DAMA) SCPC or time division multiple access (TDMA) channels. They are not well suited toward broadcast-oriented applications.

One simple satellite transmission technique is the preassigned SCPC technique. This method is a circuit-based access scheme and consequently provides a simple circuit from one point to another point. This method is very useful, both economically and functionally, when all that is required is a transmission link from one station to another station. **Figure 5** illustrates how such a link would appear.

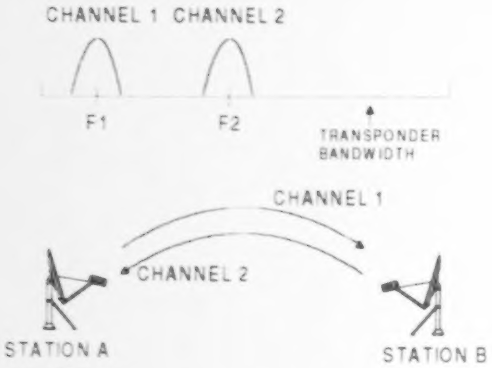

FIGURE 5. SCPC ACCESS

Each station transmits a carrier at a unique frequency that is not shared with any other stations. Station A transmits at f_1 and Station B transmits at f_2. On the receive side, Station A will receive at f_2 and Station B will receive at f_1. These satellite channels are on fixed frequencies and are not shared with any other stations.

Another common access technique is the TDMA technique. In this access scheme all stations transmit and receive on the same frequencies. The access to these frequencies is based on time. The satellite bandwidth is "divided" on the basis of time to provide for access to the common frequency by multiple stations. A map of when each station is to transmit called the "network burst time plan" is used to ensure that each station transmits its "burst" of data at the correct time. The network timing and the network burst time plan together ensure that no more then one station will transmit over the frequency at one time. On the downlink, each station will "see" or receive from the satellite a series of bursts from all the stations in the network. On the receive side, the stations will use the burst time plan to determine which data bursts are directed for them and should be decoded and passed to the connected devices.

Figure 6 shows this topology.

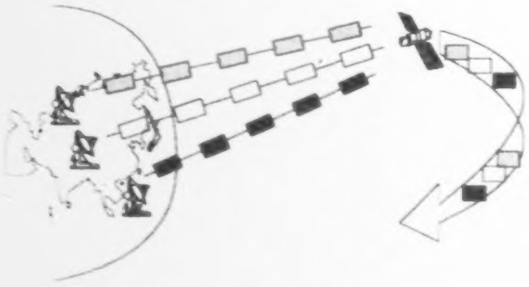

FIGURE 6. TDMA ACCESS

Similar to TDMA, but in the reverse direction, is time division multiplexing (TDM). A TDM carrier is a single carrier that is broadcast from a host site to all other remote sites. The data transmitted over the TDM channel is packetized and addressed to individual remote stations. In this manner, one site is able to communicate in a one-way fashion to multiple sites.

POINT-TO-POINT SATELLITE CONFERENCE

Point-to-point videoconference applications are relatively straightforward. Both SCPC and TDMA access techniques can satisfy these applications. The most common choice is the SCPC access, as this provides a very scalable solution for the transponder usage. In the case of TDMA the network designer is required to set aside at least 1.5 Mbps or more of satellite capacity - which may or may not be required for the videoconferencing application.

It should be noted that the bigger issue for network design of point-to-point applications is the question of call setup. It is unlikely that there will be dedicated links for stations. Instead, the links will need to be constructed on a per call basis. The most common interface for call setup in video application is integrated services digital network (ISDN). Thus, it is important that the VSAT system to support the point-to-point mode be able to provide an ISDN interface. This allows the transponder capacity to be reallocated based on actual need.

MULTIPOINT SATELLITE CONFERENCE

From a system design point of view the most interesting problem is to design for multipoint videoconferences. The challenge here is to minimize the use of satellite transponder capacity while still providing the connectivity that is required.

A simple solution would be a system that establishes one site to be a master controller site with the other sites defined as slaves. The master site would be seen and heard by all sites, and the slave sites pass a "token" to identify themselves to be seen and/or heard by the other slaves. The master site can always choose which slave site (or sites, depending on available monitors and room equipment) is seen on their monitors. This solution requires the use of a bridge device or multipoint control unit (MCU) at the central station to handle the switching. This solution is particularly expensive, as each station that is active will have a full duplex satellite channel whose capacity is equivalent to the video transmission rate. Thus, if there are nine remote stations, then the system will consume nine 384 kbps circuits.

A better solution for this type of application would be to take advantage of the broadcast nature of satellite and make the VSAT remote station "smart" enough to determine if it should transmit or simply receive.

Hughes Network Systems has developed an architecture that combines both TDM and TDMA access technology in order to provide the optimum architecture for videoconferencing applications. In the inTELEconference™ system the network requirements are viewed in two separate pieces. The first piece is the video, which is broadcast from one site to multiple sites. The second piece is the audio, which is combined from all sites and then broadcast to all sites.

For the video portion of the network, a TDM channel is most suitable, for the reason that one site will be able to broadcast its video to all other remote stations in the network with only a single carrier. If a TDM carrier is used for the video broadcast, it is important that the VSAT have the "intelligence" built in to decide which site should broadcast at which time. In order for an SCPC network to do this same thing would require that each site have its own carrier transmitting to a central site, which in turn would rebroadcast the selected "host" video signal to all other remotes in the network, again requiring individual carriers for each site in the network.

For the audio portion of the network, each remote station must contribute its audio signal by sending it to all other remote stations on the network. Because every station must do this same thing, there must be some vehicle to arbitrate satellite access, and hence the audio channel is best accommodated by a TDMA channel. In order to have the same results using SCPC, it is again necessary to transmit a carrier from each station to a central site, which in turn would concatenate the audio signals using external equipment. The audio signals could, however, be piggybacked onto the video signals.

Thus it is seen that a combination of TDM and TDMA technologies best accommodates videoconferencing applications. This is shown in **Figure 7(a)** and **7(b)**, which is an architecture comparison for a small (four-site) network with an N-way multipoint conference. The benefit derived from using the proper technology increases with the number of sites in the network, as the number of carriers required for an SCPC videoconferencing network with a large number of sites becomes unwieldy.

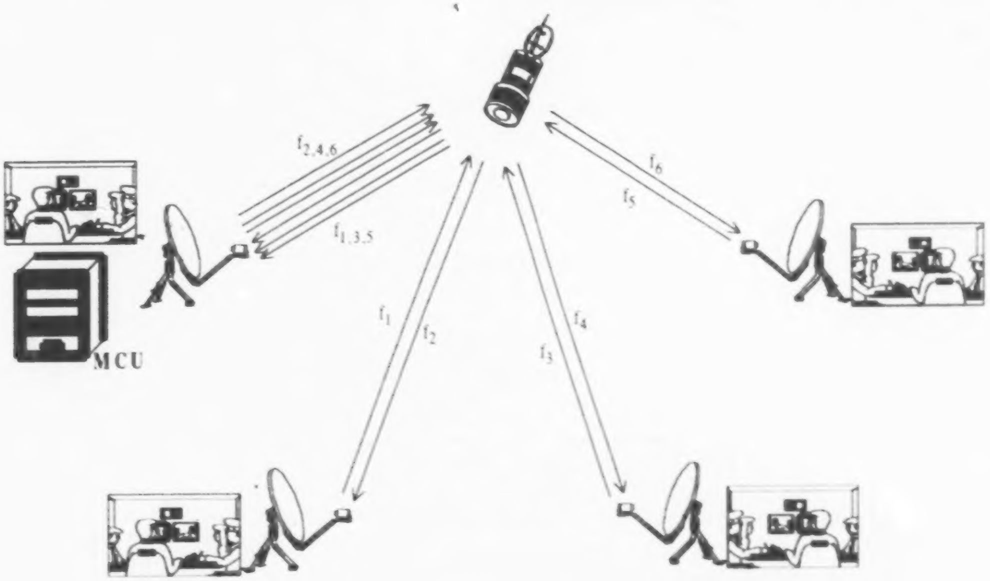

FIGURE 7(A). SCPC ARCHITECTURE REQUIRES SIX CARRIERS.
TWO MORE CARRIERS ARE REQUIRED FOR EACH ACTIVE SITE ADDED TO THE NETWORK

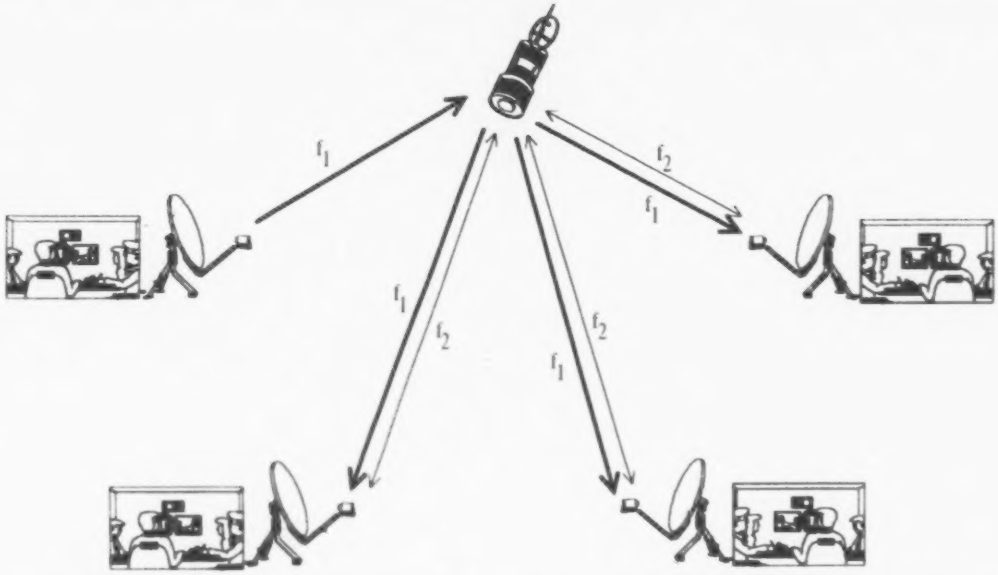

FIGURE 7(B). TDM AND TDMA COMBINATION (INTELECONFERENCE ARCHITECTURE) REQUIRES ONLY TWO CARRIERS.
NO ADDITIONAL CARRIERS NEEDED FOR ADDITIONAL ACTIVE SITES.

Functionality

A combination TDM video and TDMA voice VSAT system can be operated in any of four videoconferencing modes:

- Broadcast - One site can transmit video and audio to any number of remote sites.
- Two-Way - Any two sites in the network can participate in a fully interactive videoconference.
- Multipoint (N-Way) - Up to 16 sites can hold a videoconference in which one site is the host (it transmits the video), while the other sites transmit audio. In addition, as the meeting proceeds, any of the sites can become the host site. Throughout the conference, all sites hear all other sites.
- Two-Way with Multipoint (2+N-Way) - Similar to the multipoint mode but with two of the sites holding a two-way videoconference; these two sites are referred to as the host and guest sites. The host site can selectively view any of the other sites, while the remaining sites view the host and participate on an audio basis. As the meeting proceeds, any of the other sites can become the host site, and the host site can select any of the other participating sites as the guest. There is no limit as to the number of times that the host and guest sites can be switched.

A network control center (NCC) manages and controls the network via a reservation-based scheduling system. The NCC processes requests for videoconferences and also polls each remote site to monitor its status. An NCC control channel and one or more videoconference traffic channels are used for transporting the videoconferences through the network. Given sufficient satellite traffic channels, the TDM video/TDMA voice system can support multiple simultaneous videoconferences, with each conference operating in any of the four modes described above.

The transmission and control system uses VSATs to transmit the compressed videoconference images via satellite. Video compression techniques are used to reduce the amount of information required for transmission, yielding lower operating costs. A videoconferencing system consists of several remote sites, managed via a dedicated NCC. The system provides the network transmission and control subsystem.

CONCLUSION

For many areas the most practical and economical method to achieve interactive videoconferencing is through the use of VSATs. For applications where simple point-to-point connectivity is required, the use of common SCPC VSAT systems are the best solution. For those applications where multipoint connectivity is required, it is necessary to look for a specialized architecture that can economically connect the videoconference participants so that a minimum of satellite transponder capacity is required.

Mobile Business Applications -
Examples of global applications through existing satellite networks and those in planning.

Dr Ramin Khadem, Inmarsat
London, United Kingdom

This paper provides an overview of Inmarsat and some of its key business applications in the field of mobile satellite communications, ranging from newsgathering with real-time video delivery from remote, war and disaster locations to emerging applications aboard airlines and ships at sea to the applications of monitoring of information related to large technology projects on land. It also focuses on future developments currently in the planning phase.

INTRODUCTION

Much is made today of the potential of mobile satellite communications. In the forefront of the technical revolution, the mobile satellite communications sector, along with its terrestrial and cellular counterparts, has embarked on a major expansion of services, moving quickly into vast new markets and applications. Satellite communications extend the freedom of movement offered by cellular phones to encompass the entire planet - global mobility is no longer a thing of the future - it is here now.

With smaller equipment and lower costs, markets for satcoms will be pushed from the tens of thousands of users we have today to hundreds of thousands worldwide by the turn of the century. In time, terrestrial and cellular mobile networks will be integrated increasingly with mobile satcoms. In recent years, there have been announcements for an array of futuristic mobile satellite services by several potential operators - these developments will result in a higher profile for satellite services as new uses for the system are identified.

BACKGROUND

Inmarsat was created in 1979 by an international agreement to provide services to ships at sea. Service began in 1982 and the maritime market for mobile satcoms has increased ten fold since then. Under its agreement, Inmarsat is required to provide services in all geographical areas where mobile communications are needed and the Organisation's space segment is open for peaceful, non discriminatory use by all nations, whether or not they are members of Inmarsat.

As a demonstration of the growing value of global mobile satellite systems, when service began in 1982, Inmarsat had 28 member states; now it has 79 members and its services are used in more than 150 countries.

Inmarsat is embarking on major expansion to change the face of mobile satellite communications with virtually the entire evolution in mobile satcoms pioneered by Inmarsat and so far coming about largely through Inmarsat initiatives. A growing family of services has been developed and introduced, extending Inmarsat's traditional reach of maritime services to include the aeronautical and land mobile markets. In 1995, Inmarsat sponsored the creation of an affiliated company, ICO Global Communications, to deliver a handheld satellite phone service which would be interoperable with cellular. ICO Global Communications is now extending this element of mobile satellite telephony along with a number of other operators who have declared their intention to exploit such opportunities. Today Inmarsat provides the world's first personal global satellite communications service through phone and data terminals the size of a small briefcase and even smaller. As these services evolve through the decade, they will bring about significant growth and change in the industry and a major expansion in the user community.

THE SYSTEM - CURRENT AND PLANNED

Inmarsat uses its own quartet of second-generation satellites and leases Marecs B2 from the European Space Agency, Maritime Communications Subsystem payloads on several Intelsat Vs from the International Telecommunications Satellite

Organisation and capacity on Marisat satellites from Comsat General of the United States.

Each Inmarsat-2 spacecraft, the fourth and last of which was launched in April 1992, has a capacity equivalent to 250 Inmarsat-A voice circuits.

Inmarsat has contracted Lockheed Martin to build five Inmarsat-3 satellites featuring spot-beam capability for launch from March 1996.

The new Inmarsat-3 satellites, which at 48 dBW L-Band EIRP, provide about 10 times the capacity of the second generation satellites, will feature, in addition to global beams, moveable spot beams to provide greater power and capacity on demand to regions which most need them. Inmarsat-3 will also feature a navigation package.

Land earth stations (LESs) - referred to as coast earth stations in the maritime environment and ground earth stations in the aeronautical - link Inmarsat's satellites with the national and international telecommunications networks. Each LES is generally owned and operated by the Signatory (the organisation nominated by its government to invest in Inmarsat) of the country in which it is located.

INMARSAT SATCOM SERVICES AND APPLICATIONS

Inmarsat-A: Designed to provide voice and data communications and distress alerting services to ships at sea, Inmarsat-A was the only available mobile satellite terminal during the 1980s. With the introduction of terminals in a transportable form, the Inmarsat-A service continues to grow steadily, with more than 25,000 terminals in operation today on land and at sea.

In the maritime environment, Inmarsat-A has been meeting the satcoms needs of ocean-going ships for over 15 years. The crews of more than 17,600 ships - from massive oil tankers to fishing trawlers - use Inmarsat-A terminals for commercial and social purposes and for safety and distress communications.

Terminals receive and transmit in the L-band (1.5/1.6GHz). Communications between satellites and 26 land earth stations located around the globe are conducted in the C-band (4/6GHz).

On land, transportable Inmarsat-As are widely used by journalists and relief agencies in regions where terrestrial links are unreliable or non-existent. Semi-fixed Inmarsat-A installations are a very effective means of supporting remote-area operations such as surveying, pipeline work, construction, forestry, drilling and mining. Semi-fixed and transportable Inmarsat-As can also be used for emergency communications backup at remote office sites. High quality photographs can be transmitted and received via Inmarsat-A, particularly useful for the media and survey teams who can send pictures to city-based offices from remote sites instantly. Using video compression techniques, news and sports telecasts can also be transmitted via Inmarsat-A.

In transportable form, an Inmarsat-A terminal is packaged in one or two suitcase-sized carrying cases with a foldaway parabolic antenna measuring about a metre in diameter. Weighing between 20 - 50kg, transportable terminals are easy to set up and work off batteries or portable power supplies. Vehicle-mounted terminals generally have dynamically driven antennas which track the satellite regardless of vehicle movement. Applications include communications in support of long-distance races such as the Paris-Dakar Rally.

Satcoms enabled delegates travelling by train from Warsaw, Poland to the recent World Conference on Women in Beijing, China, to send and receive email messages during their eight day journey.

An Inmarsat-A satphone was set up outside the Beijing Express train during the regularly scheduled stops. Participants were encouraged to use the satphone for email. Journalists used the equipment for filing stories.

Inmarsat-B: Inmarsat-B is seen as the digital successor to the Inmarsat-A system, although the two will co-exist well into the next century. Introduced in 1992, Inmarsat-B offers digital voice, circuit switched data and facsimile at 9.6 kbit/s. These services are similar to those currently available through Inmarsat-A, however the digital implementation will result in considerably improved use of satellite power and bandwidth, permitting significant reductions to end user tariffs. Inmarsat-B appeals particularly to existing high-volume users of Inmarsat-A. In the maritime environment these include the offshore exploration industry and cruise-ship operators. On land, customers include the media (compressed video and broadcast-quality audio transmission over high speed datalinks), government agencies and peacekeeping forces (using the encryption capability), aid organisations and all those who require full office communications in areas lacking a fixed telecommunications infrastructure.

Inmarsat-C: Introduced in 1991, Inmarsat-C offers two-way store-and-forward global mobile satellite communications using terminals small enough to be hand carried or fitted to any vessel, vehicle or aircraft. Over 100 different terminal models from nearly 40 manufacturers have now been approved to operate with Inmarsat-C.

The Inmarsat-C system allows for the transmission of data (such as location, speed and heading, fuel stocks and consumption) at prearranged intervals, or the user's company can interrogate a mobile terminal at any time, triggering the automatic transmission of the required information. Terminals can be linked or integrated with a wide variety of navigation systems to provide a highly reliable, round-the-clock global position-reporting capability. The typical Inmarsat-C mobile earth station has a small omni-directional antenna which, with its light weight and simplicity, can be easily mounted on a vehicle or vessel. Directional antennas are also available for use in semi-fixed installations. The main electronics unit is compact, weighing only 3-4kg. Briefcase terminals are also available, bringing the advantages of the system to international business travellers and field operators. Inmarsat-C terminals can be programmed to receive multiple-address messages known as Enhanced Group Calls (EGC), which can be transmitted in most languages or alphabets. There are two main types of EGC:

SafetyNET™ provides an efficient and low-cost means of transmitting maritime safety information to vessels at sea and is used by hydrographic, search and rescue, meteorological and coastguard co-ordination authorities. Messages can be directed to mobiles in or approaching specific regions, for example, the sea area around a rescue co-ordination centre.

FleetNET™ allows commercial information to be sent to a virtually unlimited number of predesignated mobile terminals simultaneously. It is suitable for use by services specialising in the distribution of news, stock exchange reports, sporting results, weather analyses and road and port information.

In the western Pacific Ocean, a Trimble Inmarsat-C/GPS installation has enabled US federal agents to catch a vessel fishing illegally in protected waters inhabited by the endangered Hawaiian monk seal.

In June 1995, the US fisheries service was alerted via satellite to the presence of a long-liner in the protected area. The fisheries service alerted the US coast guard who boarded the boat eight miles into the 50 mile protection zone. Once aboard, officials discovered 10,000 pounds of swordfish and tuna in the hold and 13 miles of long-line gear in the water. The vessel was sent back to Honolulu for investigation. Although she was unescorted, fishery authorities were able to monitor her return by satellite.

Inmarsat-C is being used for land mobile applications in increasing numbers, and in addition to routine two-way messaging and data communications, Inmarsat-C has a variety of applications.

Satcoms had a crucial role to play in relief efforts following the hurricane which swept through the Caribbean in September. At least 16 people were killed by Hurricane Luis, which caused an estimated $700 million worth of damage in Antigua, St. Kitts and Nevis, St. Maarten, Dominica and other Caribbean islands.

The Caribbean Disaster Emergency Response Agency (CDERA) and the Pan American Health Organization (PAHO) used Inmarsat-A and Inmarsat-M satphones and Inmarsat-C data transceivers to provide on-the-spot communications. CDERA first began using satcoms two years ago when the agency acquired three Inmarsat-Cs for use in co-ordinating emergency responses in the region.

For truck fleet operators, Inmarsat-C enables vehicle fleets to be constantly monitored and directed for efficient management of rolling stock.

Truck drivers moving cargoes can send near-instant data reports to their offices anywhere in the world - either automatically, at timed intervals or manually. At the other end, the operators of these trucks can "poll" or interrogate their truck drivers for specific information on their progress.

The compactness and easy operability of Inmarsat-C enables it to be used for remote monitoring of installations, such as water pumping stations and oil and water pipelines. Unmanned, transmit-only Inmarsat-C terminals can be installed at various points at the remote site and connected to a central monitoring station where parameters, such as water levels, can be remotely monitored and controlled.

Finally, a growing customer base for Inmarsat services is the international business traveller. The briefcase version of Inmarsat-C allows the international business traveller to stay in touch with the office whatever the time of day and irrespective of the availability of local communications services. With Inmarsat-C and a laptop computer, the international business traveller can send or receive electronic mail or book a flight with a travel agent from virtually anywhere on earth.

Inmarsat-M: Inmarsat-M is a system providing good-quality phone and low-speed (2.4kbit/sec) fax services everywhere in the world with the exception of the poles. A 2.4kbit/sec data capability will shortly be commercially available. Compared with Inmarsat-A, an analogue system, the digital Inmarsat-M demands less bandwidth and satellite power, resulting in lower operating costs and terminal power requirements. Inmarsat-M terminals vary in design and size, some being smaller than a briefcase and can be fixed, hand-carried or installed on vessels and vehicles. Antennas vary in size and shape, from mechanically steered and gyrostabilised parabolic units for ships to simple flat-plane arrays built into briefcases.

The frequency bands for land-mobile terminals are 1525.0-1559.0MHz (receive), 1626.5-1660.5MHz (transmit). Maritime bands are 1525.0-1545MHz (shore-to-ship), 1626.5-1646.5MHz (ship-to-shore).

Inmarsat-M offers worldwide coverage. The terminal transmits to the satellite covering the ocean region in which it is situated. The call is then passed to a land earth station, which either routes it to a terrestrial telecommunications network or relays it to another Inmarsat mobile terminal.

Sales of both maritime and land-mobile terminals have grown rapidly since the global launch of Inmarsat-M in September 1993, with over 7,000 terminals in service to date. Users include journalists, diplomats, aid workers, business travellers, railway operators, border patrols, emergency services and anyone operating in areas beyond the reach of cellular or fixed communications.

> *Thailand turned to mobile satcoms technology to speed the reporting of results in the country's general election in July 1995. The Communications Authority of Thailand used an Inmarsat-M satphone to report the result of the election from the remote and isolated area of Ban Mae Dad Noi, 200km from Mae Cham district - one of the main election constituencies of Chiang-mai province in Northern Thailand.*
>
> *During previous elections, a helicopter has been used to transport the results to Mae Cham, however, the helicopter cannot fly in bad weather. On such occasions, a motorcyclist would drive along hilly, unpaved paths for between seven and eight hours to deliver the results. In this year's election, the results from Ban Mae Dad Noi were reported to Mae Cham within one and a half hours of the end of the election. This was approximately four times quicker - and considerably cheaper - than before.*

Inmarsat-Aero: This aeronautical satellite commun-ications system offers phone, fax and data services for passenger, operational, and air traffic control communications on board commercial, corporate and general-aviation aircraft flying anywhere in the world.

Until satcoms, aviation was limited to radio communications which suffered from the line-of-sight limitations of VHF and the unreliability and variable quality of shortwave radio. Satellite links transcend these inherent weaknesses and are unaffected by distance or ionospheric conditions. The applications of satcoms for aeronautical communications are far reaching.

There are currently three main applications for aeronautical satcoms:

Passenger Services: Inmarsat supports multichannel phone, packet-mode data messaging at up to 10.5kbit/sec, fax and circuit-mode data at up to 4.8 kbit/sec. In addition to making phone calls and sending faxes anywhere in the world while in flight, passengers are being offered a growing range of data services. They include duty-free shopping; airline, hotel and car-hire reservations and real-time world and financial news.

Air Traffic Control: Inmarsat aeronautical satcoms will play a major role in the implementation of ICAO's CNS/ATM (Communications Navigation Surveillance/Air Traffic Management) concept for air traffic control in the next century. The Inmarsat satellites will support automatic dependent surveillance (ADS) over the oceans and wilderness areas. ADS is the reporting via satcoms of position and intention information derived from the aircraft's own navigation systems. Presented on radar-like displays at oceanic control centres, it will give controllers real-time knowledge of the traffic situation, permitting more fuel-efficient routing and reduced separation standards.

Improved routing is expected to yield millions of dollars in fuel and other operational cost savings, while reduced separations will increase the capacity of oceanic and wilderness airspace.

The Inmarsat-Aero datalink will be used for ADS and routine pilot-controller communications such as requests, clearances and advisories. Voice will be used for non-routine and emergency communications.

ATS applications using the Inmarsat-Aero system became operational in the South Pacific from September 1995.

Airline Operational and Administrative Communications: use of satellite datalink to integrate aircraft in flight more closely into airline information systems can yield significant increases in operational and administrative efficiency.

Possible applications include support of ETOPS (extended-range twin operations); in-flight troubleshooting of technical problems and improved handling of irregular operations resulting from weather and other delays.

Inmarsat services for aircraft are supported by three systems:

Aero-C: the aeronautical version of the Inmarsat-C low-rate data system. Aero-C allows store-and-forward text or data messages - flight safety communications excluded - to be sent and received by aircraft operating anywhere in the world.

Aero-L: low-speed (600 bits/sec) real-time data communications, mainly for airline operational and administrative purposes.

Aero-H: a high-speed (up to 10.5 kbit/sec) service supporting multichannel voice, fax and data communications for passengers and airline operational and administrative applications.

In addition, the Aero-I intermediate-gain system is being developed for introduction in 1997. Designed to exploit the higher power of the Inmarsat-3 satellites, Aero-I will make it possible for aircraft flying within spot-beam coverage to receive Aero-H levels of service through smaller, cheaper terminals.

Over 700 aircraft have been fitted with Inmarsat-Aero terminals. These include more than 200 corporate and government aircraft and over 350 installations in airliners. Corporate users favour phone and fax service, while the airlines also make use of the data service. In addition, more than 260 business aircraft, helicopters and military transports are fitted with the Aero-C version of the Inmarsat-C low-speed store-and-forward data system.

> *New Zealand has become the first country to complete successful testing of a satellite-based air traffic control system with the introduction of its Oceanic Control System.*
>
> *The OCS, developed for the Airways Corporation of New Zealand by CAE Electronics of Montreal, is a satellite system that enables air traffic controllers to track aircraft within the controllers' oceanic airspace on a visual situation display. The system provides an ocean-wide pseudo-radar system that allows aircraft greater flexibility in routing.*

Inmarsat-D - Global Satellite Paging: The world's first truly global messaging system, Inmarsat-D, will be commercially available in the second quarter of

1996. Operating via the Inmarsat satellite system, Inmarsat-D receivers will be able to store and display a large number of messages of up to 128 characters in length. Potential users are primarily agencies requiring a broadcast capability (such as providers of currency exchange rates, news bulletins, stock market information and warnings of stolen credit cards), commercial organisations (transport fleet operators, utility companies), government agencies and travellers to the developing countries. Inmarsat-D will provide a natural extension to terrestrial paging services and will make one-way global mobile satellite communications available to a wide range of users at very competitive prices. The first Inmarsat-D land earth station is under construction with others in planning.

A number of receiver types are in development for introduction in time for the launch of the Inmarsat-D service:

- pocket size receiver
- customised receiver for commercial vehicles and semi-fixed applications
- receiver integrated into briefcase Inmarsat-C or Inmarsat-M

Service features for Inmarsat-D:

- subscribers will be able to receive tone, numeric and alphanumeric messages as well as various forms of data. Callers will be able to broadcast to multiple users simultaneously.
- callers will be able to select from among four categories: priority, urgent, normal, non-critical
- subscribers will have protection against message loss and will be able to specify the number of retransmissions. Messages will be time-stamped and numbered for easy retrieval. Subscribers will be able to activate paging services and to set parameters such as where and when messages are to be received.

Other applications for which Inmarsat-D would be used include financial and stock market updates; weather information and news bulletins.

INMARSAT'S INVESTMENT IN ICO GLOBAL COMMUNICATIONS

In January 1995, Inmarsat played a significant role in the formation of a company to implement a global hand-held satellite phone system, which became ICO Global Communications (ICO). Most of the investors in ICO are national telecommunications authorities. One of the exceptions - but the biggest, with a $150 million stake - is Inmarsat, who first saw hand-held personal satcoms as a natural objective in the mid-1980s. Despite its investment level, Inmarsat holds a minor equity stake in the $1.5 billion equity backing of ICO and its relations with ICO are purely at arm's length.

ICO is legally and physically distinct from Inmarsat and has its own board and management. It is privately owned, with no government involvement. But there are some strong linkages with Inmarsat, which will act as the wholesaler of aeronautical and maritime services and is currently performing various tasks for ICO under the terms of a service contract. The company's 13-member board includes two Inmarsat members.

The formation of ICO was the culmination of Project 21, an Inmarsat-led initiative launched in September 1991. The primary objective of Project 21 was the implementation of global satellite service to pocket-sized phones by the end of the decade. When it is introduced in 1999 - 2000 the new system will be available globally.

Total system cost is expected to be $2.6 billion, more than half of which was raised in the initial funding drive. Since then another four telecommunications entities have invested, while Hughes has taken a substantial stake in its role as an equity investor as well as a satellite contractor.

CONCLUSION

Mobile satellite communications is already one of the most exciting arenas to watch or participate in. Over the next few years, it is likely to become even more so.

Change and growth there will be. New technological developments will continue to shrink the size and cost of equipment and open up new markets. Customers will create their own pressures for freedom of access to mobile satellite services which, in turn, will influence both the spectrum issue and national regulatory positions. New satellite operators will emerge, they will fight for whatever markets develop, and some, but not all, will survive. Inmarsat itself will likely change as the environment becomes more competitive and as markets increase Inmarsat is fully committed to a market driven approach to the way it does business.

But it will be the customer above all who stands to reap the benefits of these developments in terms of more choice, more flexibility, and the ability to communicate easily and inexpensively to and from anywhere on earth.

SOFTWARE OPPORTUNITIES IN THE INFORMATION INFRASTRUCTURE

Saurabh Srivastava
Chairman
Electronics and Computer Software

Few people question the fact that information will now define the new work order. Focusing on the information infrastructure is therefore extremely relevant. It is important, however, not to confuse the end with the means sand information with information technology. Because our goal, at the end of the day, should be to create an information rich society to achieve five clear objectives:

1. Enhance the quality of life of societies.
2. Enhance the potential of individuals.
3. Link communities locally and globally.
4. Boost economic growth
5. Improve productivity and efficiency

Rather than dwell on specific technologies, therefore, I would prefer to focus on how the information infrastructure can provide a means of achieving these ends. Possible the best example I can think of which illustrates what I mean, is Singapore. Through a clear, undiluted focus on the objectives which it wanted to achieve (which are not too dissimilar to the ones I've listed), the country has had major success, not only in building a high quality information infrastructure but also in meeting its targeted objectives.

The other focus of my talk today is on how we can harness the tremendous potential represented by the developing world. Firstly, the major markets for tomorrow are going to be provided by the developing world such as India and China, for example. Equally importantly, the bulk of humanity today resides in these countries. To my mind therefore any discussion which does not focus on how we will harness their tremendous potential and enrich these communities in the process, will be somewhat incomplete.

Many developing countries, such as India and China for instance, are in the unique situation currently where all three of "Toeffler's Waves" co-exist at the same time. This of course presents a major challenge in the management of such countries. However, if we simply change the filter through which such situations are normally viewed, we would suddenly realize the tremendous opportunities this creates.

1. It provides rich business opportunities in such countries for companies in the developed world.
2. It creates opportunities for creating new products/technologies.
3. It can enhance the competitiveness and business edge of companies that take advantage of such opportunities in market outside of the developing world.
4. In doing all of the above there is a great opportunity of improving the quality in the developing country itself.

Let me try and explain this a little further.

When today's developed world was at the stage of development in which the developing countries find themselves now, its needs were met by technologies, including IT, which by current standards are considered obsolete. There is a tendency therefore, when trying to address the needs of developing countries, to look at providing some of these older technologies, albeit at lower cost, on the assumption that these would be more appropriate to the needs of developing countries. However, I feel that such an approach would be short sighted and a serious mistake as it fails to take advantage of what is, in effect, a major opportunity.

In countries such as India and China, two of the largest markets today, while they are developing countries and possible recipients of such older technologies, the reality is that alongside all of this exist extremely high levels of expertise pertaining to Toeffler's Third Wave. This knowledge base and expertise could effectively be harnessed and managed by companies in the developed world to not only solve the issues relating to Toeffler's first two waves in these countries but, in the process, create technologies and products that would be cost effective and appropriate not only there but all over the world.

The developed world should look at doing major portions of its R&D in the developing world to produce deviants and mutations of current technology to address specific needs. Not only will this open up vast markets in these countries but the fruits of such R&D are likely to provide solutions that would have a vast potential in the developed countries as well. Such R&D would be much less costly and would fall in line with today's trend of globalisation of R&D. Let me give you some interesting statistics. Today the R&D spending by US companies abroad is rising faster than domestically. HP does 30% of its R&D outside the US and there are 250 foreign owned R&D shops in the US. Many Japanese companies such as Fujitsu, Canon, Sony, etc. recruit foreign researchers. In fact they have invented a term "techno globalistaion" to define the strong interaction between internationalization of technology and globalisation of economies.

It would significantly accelerate the pace of development of the information infrastructure if appropriate mechanisms were found to use the R&D infrastructure in many of the developing countries to develop, in a far more cost effective way, products and services that would not only meet local market needs best (being close to the market) but would also serve the needs of companies worldwide.

If you look at India alone, there are close to 1500 major R&D establishments, over 200 Universities, 8000 colleges, 25,000 High schools and thousands of Phd's produced every year.

In effect even the current level of the information infrastructure provides the opportunity for such globalisation of R&D which was missing a few years ago. An increasingly inexpensive and wide spread communications facility creates possibilities that would have been unthinkable some time back. "The global village" is here now and we need to collapse residual barriers which increasingly exist only in our minds and are relics of past thinking.

Let us get even more specific. If we take India for instance it has very little entrenched investment in the "wired world". Therefore there is a unique opportunity to use the latest technology on a scale and in a way that would be difficult to do in the developed world where there are major existing investments in older systems. There will be a need to reduce cost parameters to extend the information infrastructure to cover billions of people but in doing so, the solutions created will gain wider spread throughout the developed world as well.

To get literally hundreds of millions of people to electronically send and receive information will need a difference cost paradigm. In countries where the average income is around $1500, reduction of PC prices is not going to help. Also for a vast majority of such people who are not even literate, let alone IT literate, the PC may be to complex to handle. Yet, they have a need to send and receive information. There is therefore a market for new kinds of solutions to meet this need. In solving this problem, and breaking the existing technology and cost paradigms, we would have created and innovated products and solutions which would result in unleashing a vast untapped potential, as significant for the IT industry as the emergence of the PC in the recent past. This R&D would never be done in the developed world as one would neither see the market need nor the economic viability of making the significant investment that this would entail at the currently high prevailing costs in such countries. On the other hand, by changing the filter and looking at the much lower costs of doing R&D in developing countries, coupled with the huge markets that could be topped as a result, the investment decision would suddenly be a viable one. Simply selling older or even current technologies or products in these markets would leave most of the potential in the developing world untapped.

Building any infrastructure, be it related to roads, rail or information is only as worthwhile as the use to which it is put for servicing people. It would be appropriate to use the term "information infrastructure" only if it truly is one. I.e., a vast majority of today's populace should be able use it for both business and personal gain. This will only happen if sufficient software is put on this infrastructure. There is therefore a great need for a large number of not only software developers but also of information providers. This in turn is going to create a huge demand for computer literate people for developing software solutions, collecting and feeding information. The developing world today has a tremendous potential for providing this resource. If the companies in the developed world invest in training and managing this vast potential resource, we would have unleashed a powerful driving force that we need to tap the full potential of the information revolution.

Even more, it is in the developing countries that we will find the "test beds" to create new solutions and applications that will substantially further the spread of the information revolution. For instance, many of the technologies and solutions being developed today assume certain penetration levels are fundamentally different and will take some time to increase. The information needs, however, are almost the same. There is therefore a huge market for services such virtual phones that are not necessarily global but confined to smaller geographical boundaries and managed in a cost effective way. All of them represent huge opportunities for companies that are willing to adapt to a different paradigm and innovating.

While we are moving into new technical solutions, there is a need for an approach where the older technologies in existence can be maintained and even enhanced and better harnessed to provide an appropriate bridge between the two systems. Clearly, the developing world will be a better and cheaper source for doing this. We should use the existing telecom infrastructure to encourage the outsourcing, from the developed to the developing world, of such applications as maintenance of legacy systems, insurance claims processing, airline reservation and many others which will have the added benefit of improving service levels and the quality of life of people everywhere. We are already seeing several examples of this. Insurance companies in the US dare processing their claims in Ireland. In doing so, they are not only reducing the cost to their consumers, but are also tremendously increasing service levels with no change in quality. Because of the time zone difference a person can submit an insurance claim at 5 p.m. on Monday and have it processed by 9a.m. on Tuesday. Doctors at hospitals in the US are dictating notes on to voice mail and, by the next morning have the typed version with them, as the transcription is being done by a Company in India. Once again, the availability of a high quality resource in a different time zone at much lower costs makes this possible. Many companies in the West, while they focus their energies on developing their new generation of software product and are outsourcing the world wide support, maintenance and enhancement or older products, to companies in India and elsewhere as this is the only economically viable way of continuing to provide their existing customers a reasonable level of service and a bridge, while they focus on the next generation of products. Such examples abound and represent and excellent use of the information infrastructure.

I could go on with more and more examples but I think the points have already been made. The information infrastructure is going to be perhaps the most significant of all global infrastructures that have been created, clearly surpassing the potential of such traditional ones as rail, road and airlines. It will serve to bring the world together like never before. If we use it as a means of harnessing the tremendous resources and potential of people the over the globe, we will not only accelerate the pace at which this infrastructure develops but will ultimately succeed in achieving the real objectives that such an infrastructure should have. I refer of course to the goals I have enumerated at the start, which relate to enhancing the quality of life, boosting productivity and economic growth and linking communities together.

Enabling Software Capabilities for the Global Information Infrastructure

Dr. Richard S. Wolff
Bellcore
Morristown, New Jersey, USA

1. ABSTRACT

Rapid advances that have occurred in the past decades in computer and communications technologies provide the opportunity to realize a seamless, worldwide web of communications networks, computers and databases. There remain critical technology and policy issues to be resolved. This paper presents a set of interrelated enabling infrastructure capabilities for information networks that must be addressed to enable the Global Information Infrastructure.

2. SUMMARY

The importance of an advanced Global Information Infrastructure (GII) in achieving broad economic and social goals has been clearly articulated in the policies and actions of governments world-wide. The rapid advances in the past decades in computer and communications technologies, including software engineering and modularity, high-speed very large scale integrated circuits (VLSI), optical networking, distributed computing systems and human interface technologies, provide the opportunity to realize a seamless web of communications networks, computers and databases that put vast amounts of information at users' fingertips. These technologies will likely evolve into a variety of information networks, information market places, and information superhighways, all under the the integrating vision of a GII. Establishment of the GII will result in an information revolution that will change the way people live, work and interact with each other. The communications capabilities and supporting infrastructure of the GII will make it easy for individuals, firms, government entities and institutions to conduct an increasing volume and variety of electronic commerce and lifelong educational activities on a truly global basis.

The private sectors in many nations are already actively engaged in developing and deploying elements of the necessary infrastructure. Nevertheless, there remain critical technical and policy issues to be resolved and essential roles for governments in the process. Carefully planned and coordinated government/industry action will complement and enhance the efforts already underway and ensure the growth of an information infrastructure available to all users at a reasonable cost.

The ideas discussed in this paper will facilitate production of a set of interrelated enabling infrastructure capabilities for information networks. The overall goal is to ensure that a diverse range of information consumers, network operators and information service providers can conduct their business rapidly, conveniently and cost-effectively with security and equity guaranteed for all.

3. POTENTIAL FOR GLOBAL ECONOMIC BENEFIT

The development of the GII is the means by which a broad range of economic and social goals can be achieved on a global basis. With the GII in place, nations can address their most pressing economic and social challenges more effectively, more rapidly, and with a greater assurance of success. A range of economic benefits have been identified and quantified recently by the Information Infrastructure Taskforce. These include

- Increased economic growth and productivity,
- Job creation,
- Technological leadership,
- Regional, state and local economic development, and
- The growth of electronic commerce.

The GII is likely to accrue readily identifiable benefits in areas such as health care delivery, public access to government information, life-long learning and education, and creating governments that work better and cost less.

4. TECHNICAL IDEAS FOR ENABLING CAPABILITIES

The enabling capabilities necessary for building a GII that is of greatest utility to the broadest range of users, operators and providers at the lowest cost includes those listed below. Each element in this list is discussed in detail in the individual subsections in Section 5. The enabling capabilities this paper addresses are as follows:

- generic, distributed, computing mechanisms that facilitate the creation of complex, dynamic, distributed applications;
- mechanisms that enable applications to use diverse, complex resources across heterogeneous networks;
- mechanisms that enable electronic commerce and access control through secure authentication of service requesters and a flexible billing and cost-recovery infrastructure;
- generic capabilities that support people in managing their access to an ever-increasing volume and diversity of information sources and content; and
- capabilities that aid information producers and consumers in composing, delivering and presenting multimedia information.

The capabilities that are proposed here have been selected to satisfy both the overall goals of the GII and a specific set of criteria. The explosive growth of computing and communications technologies affords an unprecedented opportunity for achieving both national and international goals, provided there is a well conceived and carefully implemented strategy to hide the underlying heterogeneities and complexities and ensure utility and convenience. The ideas set forth here are directed to address the critical, high-risk aspects of realizing the GII.

1. First, each element realizes a generally useful, application-independent, infrastructure capability for information networks.
2. Second, each builds on extensive industry experience in computing and telecommunications, manifest in research activities, prototypes, production networks, services and end systems that are entering the marketplace.
3. Finally, each additional element builds on the capabilities of its predecessors, so that the total effect is synergistic.

Taken together, and applied to a physical network infrastructure, this combined set of capabilities enables a broad class of applications for information networks that will support the full range of societal needs for the GII.

5. INDUSTRY AND GOVERNMENT COMMITMENT TO THE GII

The commitment of U. S. industry to the GII is firm and well-articulated. The telecommunications industry, in response to the Clinton Administration's Technology Initiative paper of February 22, 1993, expressed a clear and strong endorsement of the Administration's vision of government and industry working cooperatively to foster information networks. The public communications carriers expressed their view of the importance of government serving as a catalyst to promote and accelerate private sector investment in the development of an GII. The telecommunications industry has given evidence of its commitment in numerous ways. The Regional Bell Operating Companies have invested over $225 billion in their networks to date. Plans call for investing an additional $125 billion to deploy high-performance, advanced, intelligent networks by the year 2000, and more than $ 450 billion by 2015[1].

The private sector has also signaled its interest in pressing forward with the GII by its active support and participation in experimental high-speed network test beds. In all areas of the United States, efforts are moving forward through government, academic, and industry partnerships to deploy state-of-the-art networking and computing technologies and to jointly examine applications ranging from remote access to supercomputing, to distance learning, to tele-radiology. These projects all involve high risk and high cost, but the commitment is strong because the potential benefits are clearly recognized.

Similar efforts are underway in Europe and Asia. The European Commission recently launched the Advanced Communications Technologies and Services (ACTS) program with the objective of of developing advanced communications systems and services for economic and social cohesion in Europe[2]. This program is designed to take into account the rapid evolution in technologies, the changing regulatory situation and opportunities for development of advanced trans-European networks and services.

6. AREAS OF WORK AND RESEARCH OBJECTIVES

6.1 MIDDLEWARE FOR FEDERATED MULTIMEDIA NETWORKING

Applications and services in the evolving GII will be based increasingly on communications among distributed software entities, acting on behalf of end-user customers, administrators, application and information service providers, and other resource providers. Successful communications among the heterogeneous software entities in this environment requires mechanisms to allow a client entity representing, for example, a customer to locate and bind to a server entity which provides the desired functionality with acceptable service attributes (e.g., geographic coverage, price, content, format, protocol, etc.). Currently, such mechanisms , when they exist, tend to be *ad hoc* and application-specific. The problem is further compounded by the large number of embedded, or *legacy* systems which must also be accessible on the GII. Research is needed to bridge the gap between application-level requirements and the functionality of low-level distributed computing platforms. This work should lead to methods to implement middleware, the middleware blocks that are needed to allow these platforms to interwork with legacy systems, and methods and abstractions that will help to meet the interoperability and availability requirements of the GII.

As the volume and value of applications running over heterogeneous networks grows, so will concerns of efficient operation and management of the end-to-end applications, as well as the scalability, interoperability and reliability of the underlying infrastructure. Research is needed to examine and demonstrate methods of achieving broadly useful, application-independent information exchange. A possible solution to some of these concerns is to use software components in networks that are aware of, and deal with, the heterogeneity in the transport and application domains. These software components, known as *middleware*, provide functions that support multiple applications and hide the details of the underlying transport in a building-block fashion, as used in emerging client/server architectures.

The evolution of middleware is still in its early stages and commercially viable, robust solutions have yet to be found for issues such as transparent relocation and independence from network transport. In addition, a great deal needs to be done before middleware functions can add significant value for service providers. To succeed, service providers need to achieve rapid time-to-market while offering applications that are customized to end-user needs. This can best be accomplished by building applications based on middleware functional blocks that provide generic capabilities useful for multiple applications. This approach facilitates rapid customization and creation of services, minimizes time and expense by reusing components, and allows replacement of parts of the underlying technology without large-scale changes.

The success of middleware will be dependent on identifying and addressing business and service drivers. The end-user and service provider needs that must be met by the use of middleware, and the conflicts that might arise, must be resolved before middleware can be properly developed and deployed. Middleware functions can be provided by either the network or by the end-user systems. It will be necessary to identify middleware functions that may have inherent advantages when provided by the elements of the GII, as well as the requirements on these functions that are imposed by customer needs. Emerging middleware products, such as those based on CORBA (Common Object Request Broker Architecture),[3] OLE (Object Linking and Embedding), and workflow management tools for linking back-office processing to on-line network-based services, show promise for supporting the automation of transaction-based applications including ordering and banking. Middleware also has the potential to support personalized and multimedia services, as well as mobility and portability of services. Work is needed to identify and develop the middleware architectures and building blocks needed for these domains.

Platforms, architectures and systems needed to implement middleware are beginning to emerge. Environments such as the Open Software Foundation's DCE (Distributed Computing Environment),[4] the Object Management Group's CORBA, and MOM (message oriented middleware), and associated languages and protocols for telecommunications software and services (e.g., Microsoft's Telephony API, TAPI) are already proving to be useful.

Because of the large scale and scope of the GII, it will be necessary to have highly formalized and automated management and administration processes to maintain quality of service. However, the heterogeneity of a geographically dispersed network consisting of multiple administrative domains, and containing different technologies and policies, will make administration and management a significant challenge. Middleware tools and techniques need to be developed to automate the management of the GII. Issues that need to be considered include identifying what data do management activities need, how to collect the data from heterogeneous software components, how to share data across multiple administrative domains, and how to aggregate data when it spans multiple systems.

Whereas service management focuses on automating the normal operations of networks, service errors can and will occur. As the GII scales up in size, quality of service degradations, will arise from errors in service design, errors in one or more software systems providing the service, from incompatibilities among software systems, or from unforeseen interactions among different services. For reliable operation of the GII, it is critical to develop techniques to manage such errors efficiently (fault management).

Currently, error management procedures rely heavily on human experts, and are inherently expensive, time consuming and difficult to scale to large systems. Middleware techniques applicable to automating the error management functions of error avoidance by design, debugging of software causing faults, and detecting, locating and correcting error conditions in the software itself, need to be explored and developed.

6.2 CONNECTION MANAGEMENT FOR HETEROGENEOUS NETWORKS

Creation of an effective GII must address the broad and growing heterogeneity of the physical infrastructure that encodes, transports, manipulates, and stores digitally encoded media. The sources of this heterogeneity are many. They include

- international standards, created to solve specific problems (e.g., H.261, JPEG, MPEG, etc., for video and images) but which subsequently must be made to address interoperability in support of networking applications,
- heterogeneity resulting from the coexistence of multiple generations of LAN Technology (e.g., Ethernet, FDDI, ATM, etc.), heterogeneity of the public switched telecommunications networks (e.g., POTS, ISDN, SONET/SDH, ATM, Frame-relay, SMDS, etc.), and
- heterogeneity resulting from competing or coexisting proprietary standards (e.g., for control of switches, multiplexors, bridges, multipoint control units, etc.).

The challenge in creating the GII is to create a language technology and a supporting software infrastructure that isolates information networking applications from the details of the underlying technology used to manage information sources, sinks and streams. Such technology independence increases the effective market for each application and facilitates communications among disparate applications. The result is improved economic viability for each application in isolation as well as for the collection of communicating applications that realize the concept of public information networking.

Common Connection Management (CCM) is a group of functions that provide capabilities for the dynamic establishment, modification and release of general network *connections*, where *connection* refers to any information stream, of any media type, in any coding format, as well as to transformations performed on the format and content of streams by devices within a network. CCM is intended to provide an abstraction of diverse shared resources in the "network" to hide the complexity of managing heterogeneous network resources from Connection Management (CM) clients. The availability of general and efficient CM capabilities allows applications to describe complex information communications requirements in relatively simple, abstract terms, while hiding the complexity of the recruiting, control, and management of shared resources distributed throughout a network.

The CCM Interface (CCMI) is the service interface that the CCM provides to its clients for the control of network connections. For practical reasons; such as load, scale, robustness, survivability, geography and administrative partitioning, network control has to be distributed. There is no single entity controlling the whole network; control of large networks is distributed to several independent processes. In addition, parts of the network may belong to different network providers (local exchange, interexchange, private), which makes distributed control necessary.

Important goals to enable the GII are

- to define adequate specifications of the CCM interface functionality,
- to develop a language construct that facilitates realization of this functionality, to develop the needed resource allocation algorithms for the CCM, and
- to understand the important issues behind the distribution of the CCM function across diverse heterogeneous subnetworks.

The CCM should be able to be implemented in the context of a number of network technologies (e.g., analog, ATM, ISDN, etc.), including special services; such as bridges, combiners and code-transformation devices.

Some work in this critical area has been done and serves as a basis for further research. Bellcore work on connection management for the Information Networking Architecture (INA) project, the EXPANSE broadband signaling project[5] and the Touring Machine™ multimedia distributed applications infrastructure project[6] serve as examples of initial progress in addressing these issues. Successful implementation of many of these features has recently been realized in a broadband service controller utilizing object oriented software design principles[7]. Successful creation and demonstration of CMM specifications will be critical to enabling the widespread utilization of the GII.

6.3 AUTHENTICATION, BILLING AND PAYMENT

Effective and widespread commercial use of the GII will result in new businesses and industries that supply the base technologies, construct the necessary applications, and provide the desired services. However, conducting commercial transactions requires that the network infrastructure provide the necessary enabling authentication, billing and payment mechanisms. Appropriate security, privacy and intellectual property protection policies and mechanisms are critical to the success of electronic commerce on a global scale[8]. The authentication, billing and payment objectives which need to be established include ways to restrict access to communications sessions and to information resources to legitimate users, and ways to collect money from users for subscription to services, for information resources used and for the communications resources used.

6.3.1 AUTHENTICATION

User authentication is needed to ensure that only properly subscribed users access the network and information services, to ensure that the billing mechanisms are protected from fraud, and to ensure that accesses requiring multiple approvals are properly executed. While systems such as Kerberos might be applicable in some situations, the broad range of user equipment and network access technologies that will be included in the GII will require additional methods. Work at Bellcore on user authentication for personal communications has resulted in a user-authentication and session key agreement protocol specifically for use when the user's terminal has modest computational power[9]. This protocol can be used for authenticating the users by gateways between users and network service providers, by network service nodes such as multipoint multimedia conferencing units, or by information service providers. A recently developed electronic commerce system for the Internet, called *NetBill*, provides for digital signatures, encrypted goods delivery, and pseudonyms to support anonymity. *NetBill* utilizes an open protocol that facilitates a wide variety of functions[10].

Work needs to be carried out to examine the applicability of these techniques in large-scale networks. Systems are needed to generate public keys, certificates, certificate revocation lists, etc. Directory interfaces are also needed. Applications may need to be upgraded to use these authentication procedures, and protocols may be needed to affix signatures produced by session keys to the application messages. For applications requiring multiple approvals (such as joint financial accounts, proctored tests, parental consent to view entertainment, etc.) it is necessary to link the authentication to multiple users. Finally, policies that transcend national boundaries and enable enforcement of local protocols and procedures without inhibiting international commerce need to devised, tested and adopted.

6.3.2 BILLING AND PAYMENT

Existing communications network billing platforms and applications (e.g., as used in telephone networks) will not meet the needs of services provided over emerging information networks, because these networks will consist of many independent providers[11],[12] that need to charge and be charged for services. In many cases, multiple providers may participate in what the user perceives as a single service. It is critical to the successful use of the GII that ways be found of obtaining accurate usage records for these fragmented services and of providing for flexible billing policies to recover service costs while maintaining end-user privacy and network security. Entirely new pricing models need to be established and the underlying usage measurements need to be identified[13].

Access control, billing and payment mechanisms for a public GII must include several features. They must be secure; they must be usable by end systems having modest processing capabilities, including low-power portable end systems, and they must be capable of implementing user and provider policies, such as limiting billing to preauthorized amounts. Where needed, they must be capable of producing detailed records and bills. The mechanisms must let information providers accept payment directly from users and indirectly via payment clearing house services, which perform billing and collection functions as intermediaries between information providers and users. As the use of the GII evolves, a user may receive services from several source domains, each of which maintains a directory entry containing its own information about that user for authentication, authorization, usage accounting and billing.

6.4 SEARCH AND DISCOVERY MECHANISMS FOR INFORMATION AND APPLICATIONS

Searches across the GII will be made increasingly complex by the expected escalation of potential sources of information as well as by the expanded definition of "information", which can include graphics, video clips, audio clips, entertainment, live conferences and distance-learning courses, as well as text files. Current experience with the World Wide Web, which has mushroomed in recent months, points towards both the potential and the bottlenecks associated with on-line access to distributed information. Thus, more potent mechanisms for searching out sources of desired information will be required to aid users in identifying the specific sources which best meet their requirements. More natural language capabilities need to be supported which do not require explicit matching of key words or titles. Further, hierarchical search mechanisms will be needed which ensure efficient navigation while allowing suppliers of information to control their content without intervention of any central authority.

In the GII, we envision that all information providers (e.g., journal publishers, training course developers, advertisers, movie resellers, retailers, etc.) will operate or utilize servers providing access to their contents on the network. These servers will be geographically dispersed and will be operated independently by competing or complementary information providers and server providers. For example, a large number of individual publishing houses will operate servers, as will a number of training developers, etc. The end users' task of finding the right information would become daunting unless care is taken in the design of search and retrieval interfaces. A student might want to find resources related to a particular topic, no matter who published the material; employees might seek training on particular skills irrespective of where the training was developed, or which server hosts the materials. Further complexities are introduced by language differences, limitations of end user systems, and preferences of individual end users. Suggestions of the augmenting traditional browsing tools with individual-user-centered facilities have been proposed and demonstrated on Internet-based prototypes[14]. Furthermore attention must be directed providing universal information access to accommodate users with different educational, linguistic, and basic skill levels, as well as different motivations, needs, and communications capabilities (e.g., deaf and blind users). Moreover, information suppliers and network operators will need to be prepared to deliver their services to a wide user base, equipped with a broad array of input/output devices, ranging from the telephone to an information kiosk, personal computer, or portable digital appliance. Crucial to success will be human-centered interaction, in whatever form, and through whatever modalities, users find comfortable and appropriate to the task and environment[15].

Work on some of these issues has already begun. The notion of a "server of servers" is found in WAIS, where short paragraphs describing the contents of servers can be searched and retrieved, and then a connection can be made to a server containing the desired information. This approach is promising, but it can be improved in several ways:

1. First, searching paragraph-length summaries of large, text data bases are known to lead to recall failures. The entire contents of each server can and should be indexed and used for searching.
2. Second, the indexes to be searched should be generated and updated automatically. The servers operated by information providers on the network will be changing constantly as new information is added. End users should be searching up-to-date indexes that can be generated without manual intervention.
3. Third, users should be able to structure their own views into information resources. They should be able to organize the information in a way that is meaningful to them, and they should be able to combine indexes from a number of public, commercial, and personal data bases.
4. Finally, information providers should be able to register new servers easily and provide attributes that describe their contents.

Promising results in indexing and searching documents have been achieved using approaches such as latent semantic analysis[16]. This approach would accept natural language queries from users and attempt to deal with the "synonym problem"; that is, users trying to find information without knowing the precise vocabulary used by the authors. Tests using latent semantic indexing (LSI) on standard test sets with relevance judgements[17] have shown that LSI typically improves the mean precision of retrieval across all levels of recall by approximately 20% over traditional keyword approaches.

Many content domains are making increasingly heavy use of graphics. Approximately 20% of a typical chemistry journal page is devoted to graphical information. For advertising, the figure is much higher. It will be important that a retrieval interface allow for the possibility of browsing graphics. Users may remember or be able to recognize a relevant graphic, or they may be searching for information that is best presented in a picture. Methods of extending the more promising indexing techniques, such as LSI technology to facilitate browsing of graphical displays of information, will be highly important to increasing the utility of the GII. Experience with browsing on the Internet points to the potential value of meta-information, or "information about information", which may be more valuable then the information itself[18]. Web crawlers, and other search engines, which can utilize meta-information, have evolved as an alternative to wandering through information servers. However, these tools are limited in their ability to access multimedia data because they typically deal only with text.

6.5 CREATION, DELIVERY AND PRESENTATION OF MULTIMEDIA INFORMATION

Creation of large-scale, high quality, multimedia information distribution systems on the GII requires generic capabilities which include *creation* of the content of the information, subsequent preparation of the information for efficient delivery through the network, and subsequent *presentation* of the multimedia information to the consumer, using a set of human interfaces that make it simple for non-experts to become familiar with searching and using information. This is an area of research that is critical to the success of the GII.

Work on the delivery of multimedia information over networks, such as the Bellcore DEMON project[19] has indicated promising results for an open, scalable server architecture that allows the use of commercial authoring systems to create multimedia content for real-time, network delivery over wide-area networks. More research is needed to demonstrate scalability to support mass market applications. Expertise and experience with technologies for desktop video conferencing, multimedia mail and bulletin boards, multi-user, shared computer applications, and "infinite resolution" displays needs to be targeted to human interfaces that will allow non-specialist users to access information from a variety of sources. These sources could include live video calls, stored video, and stored interactive multimedia using a graphical e-mail/bulletin board type of interface. New dimensions of the human interface will make it possible for the user to see and control new network capabilities, such as enhanced connection management, directory search and billing control. Because these activities depend on developing network services that allow effective control of these properties, we believe that this area of research has a high degree of risk but is critical to effective use of the GII.

7. CONCLUSION

The areas discussed in this paper are each key elements of a GII, and their development as an integrated, coherent whole will result in a GII in which interfaces between areas are defined and in which the architecture is naturally open; an infrastructure capable of supporting the future global information market place in all its complexity. Extensible, scalable, modular software will be the key to assuring that the GII can grow and evolve as user needs shift and expand, and underlying technologies mature and are supplanted.

REFERENCES

1. "An 'Infostructure' For All Americans: Creating Economic Growth in the 21st Century". Ameritech. Bell Atlantic; BellSouth. NYNEX. Pacific Telesis. Southwestern Bell. US WEST. April. 1993.
2. European Commission. Ref. DGXIII-B-RA946043-GI. "Advanced Communications Technologies and Services - General Information". August 17. 1994.
3. Object Management Group. *The Common Object Request Broker: Architecture and Specification*. OMG Document Number 91.12.1, Revision 1.1. 1992.
4. Open Software Foundation. *Introduction to OSF DCE*. Open Software Foundation. Cambridge. MA. August. 1992.
5. S. E. Minzer. "A Signaling Protocol for Complex Multimedia Services". *IEEE Journal on Selected Areas in Communications*. Vol. 9. No. 9. pp. 1383-1395. 1991.
6. B. A. Coan, et. al., "The Touring Machine System (Ver. 3): An Open Distributed Platform for Information Networking Applications", *Proc. 4th Int. Workshop on Telecommunications Information Networking Architecture (TINA)*, L'Aquila, Italy. 1993.
7. P. Mouchtaris, et. al., "An Object-Oriented Interface for a Distributed Connection Manager". *Proceedings 1994 IEEE International Conference on Communications*. New Orleans. LA. May. 1994, pp. 273-277.
8. L. McNight, et. al., "Federal Strategies for R&D on Heterogeneity and Information Security". *America in the Age of Information: A Forum on Federal Information and Communications R&D*. Washington, D. C., July 6-7. 1995.
9. M. J. Beller and Y. Yacobi, "Fully-Fledged Two-Way Public Key Authentication and Key Agreement for Low-Cost Terminals". *Electronic Letters*. 27 May 1993. Vol. 29. No. 11. pp. 999-1001.
10. M. Sirbu and J. D. Tygar, "NetBill: An Internet Commerce System Optimized for Network-Delivered Services". *IEEE Personal Communications Magazine*. August. 1995. pp. 34-39.
11. E. Arnum. "The Internet Dilemma: Freeway or Tollway?". *Business Communications Review*. December. 1992.
12. C. Mills. K. Laube and G. Ruth. "Internet Accounting: Usage Reporting Architecture". IETF-IAWG. July. 1992.
13. L. McNight and J. Baily. ed.. "Internet Economics". *Journal of Electronic Publication*. Univ. of Michigan Press. http://www.press.umich.edu/jep. 1995.
14. S. N.T. Shen. "Augmenting WWW Browsers with Individual-User-Centered Facilities". *America in the Age of Information: A Forum on Federal Information and Communications R&D*". Washington. DC. July 6-7. 1995.
15. R. A. Cole. et. al., "Universal Access to Information and Services Through User-Centered Human-computer Interfaces". *America in the Age of Information: A Forum on Federal Information and Communications R&D*. Washington. DC. July 6-7. 1995.
16. S. Deerwester. et. al., "Indexing by Latent Semantic Analysis". *Journal of the American Society for Information Science*. 41. pp. 391-407. 1990.
17. S. Dumais. "Textual Information Retrieval". in M. Helenader (Ed.). *Handbook of Human-computer Interaction*. pp. 673-700. Amsterdam. Elsevier. (1988).
18. D. Payton and M. Daily. "Emergent Properties of the Information Infrastructure: Planting the Seed". *America in the Age of Information: A Forum on Federal Information and Communications R&D*. Washington DC, July 6-7. 1995.
19. J. Rosenberg. G. Cruz, and T. Judd. "Presenting Multimedia Documents Over a Digital Network". *Proced. 2nd International Workshop on Networking and Operating System Support for Digital Audio and Video*. Heidelberg. Germany. Nov. 1991.

The Role of Intelligent Agents in the Information Infrastructure

Don Gilbert
with Manny Aparicio, Betty Atkinson, Steve Brady, Joe Ciccarino,
Benjamin Grosof, Pat O'Connor, Damian Osisek, Steve Pritko, Rick Spagna, Les Wilson
http://activist.gpl.ibm.com:81

IBM Corporation
Research Triangle Park, NC USA

ABSTRACT

With the move to network centric computing, complexity becomes a major inhibitor to growth. An *intelligent agent* is software that assists people and acts on their behalf. Intelligent agents can vastly reduce complexity, thus helping both experienced and inexperienced users. Eight application areas that intelligent agents can enhance are explored.

1. Introduction

Even as the world struggles to move to client / server computing, a new model has emerged: network centric computing. In this model, computing, communication, and content converge, and the network *becomes* the computer. Several key trends are thus becoming increasingly important to end users:

- Faster access to more and more information as well as improvements in the sophistication of workstation software and hardware have caused an increase in *complexity* with which users are faced.
- The volume of information available is so great it is hard to process, resulting in a dramatic increase in *information overload* for the user.
- Improvements in both packaging and wireless communications technologies have enabled an increase in the *mobility* of users.
- A coincidental reduction in hardware costs has enabled an expansion of the user population to include those with *fewer computer skills*.

Delegation of function (1) is an important response to these trends, because through delegation the computer and the networks behind it can assume more of the work. For example, software can take on responsibility for information finding, retrieval and filtering, can personalize human-computer interaction, and can enable tasks to be carried out on behalf of users whether they are present or absent, and with guidance rather than direct control by the user.

Intelligent Agents are software which implements this delegation, thus managing complexity, supporting user mobility, and lowering the entry skill level for new users. Intelligent agents can best be thought of as a *design model* (2), much like client / server computing, rather than a technology or a product offering. Though integration of intelligent agents into applications or services requires a mindset change, this new model is expected to be one of the key computing paradigms over the next ten years (3).

As a computing innovation, intelligent agents will follow a path similar to graphical user interfaces (GUIs) (2, 3): initially, agents will add value to applications, services or solutions, making offerings more competitive. Over time, however, offerings *without* intelligent agents will no longer be viable.

2. Scope of Definition

There have been many definitions of intelligent agents. At the risk of adding one more to the already crowded plate, the following is offered to help better structure the discussion of their attributes: Intelligent agents are software entities that carry out some set of operations on behalf of a user or another program with some degree of independence or autonomy, and in so doing, employ some knowledge or representation of the user's goals or desires. Intelligent agents can then be described in terms of a space defined by the three dimensions of *agency*, *intelligence*, and *mobility* (see Figure 1).

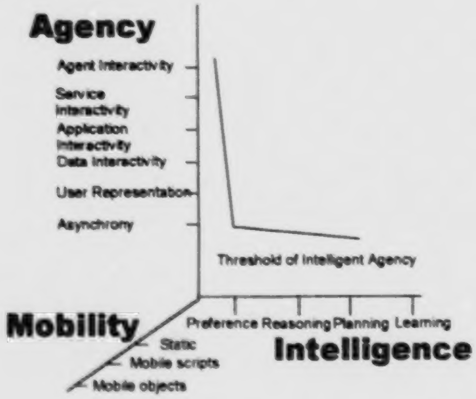
Agency
Agent Interactivity
Service Interactivity
Application Interactivity
Data Interactivity
User Representation
Asynchrony
Threshold of Intelligent Agency
Mobility
Static
Mobile scripts
Mobile objects
Preference
Reasoning
Planning
Learning
Intelligence

FIGURE 1: INTELLIGENT AGENT SCOPE

Agency is the degree of autonomy and authority vested in the agent, and can be measured at least qualitatively by the nature of the interaction between the agent and other entities in the system. At a minimum, an agent must run asynchronously. The degree of agency is enhanced if an agent represents a user in some way. This is one of the key values of agents. A more advanced agent can interact with other entities such as data, applications, or services. Further advanced agents collaborate and negotiate with other agents.

Intelligence is the degree of reasoning and learned behavior: the agent's ability to accept the user's statement of goals and carry out the task delegated to it. At a minimum, there can be some statement of preferences, perhaps in the form of rules, with an inference engine or some other reasoning mechanism to act on these preferences. Higher levels of intelligence include a user model or some other form of understanding and reasoning about what a user wants done, and planning the means to achieve this goal. Further out on the intelligence scale are systems that *learn* and *adapt* to their environment, both in terms of the user's objectives, and in terms of the resources available to the agent. Such a system might, like a human assistant, discover new relationships, connections, or concepts independently from the human user, and exploit these in anticipating and satisfying user needs.

If a piece of software falls above and to the right of the *threshold of intelligent agency*[1] in the Agency/Intelligence plane, then it is an intelligent agent under this definition (see Figure 2). For example, expert systems which are not agents may fall below the threshold, and fixed function agents such as traditional systems management agents may fall to the left of the threshold. This graph may be used to draw approximate qualitative comparisons among intelligent agent-enhanced software offerings.

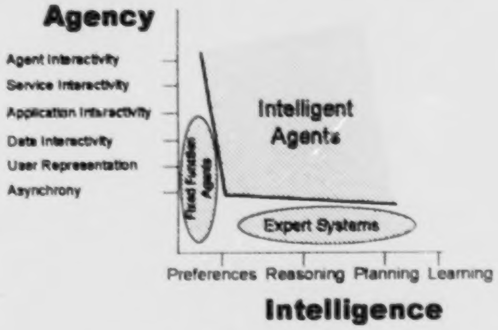
Agency
Agent Interactivity
Service Interactivity
Application Interactivity
Data Interactivity
User Representation
Asynchrony
Intelligent Agents
Fixed Function Agents
Expert Systems
Preferences
Reasoning
Planning
Learning
Intelligence

FIGURE 2:
INTELLIGENT AGENT SCOPE EXAMPLES

Networked agent applications add a third dimension to the picture (4). *Mobility* is the degree to which agents themselves travel through the network. Some agents may be *static*, either residing on the client machine (to manage a user interface, for instance) or instantiated at the server. *Mobile scripts* may be composed on one machine and shipped to another for execution in a suitably secure environment; in this case, the program travels before execution, so no state data need be attached. Finally, agents may be *mobile with state*, transported from machine to machine in the middle of execution, and carrying accumulated state data with them. Such agents may be viewed as mobile objects, which travel to *agencies* at which they can present their credentials and obtain access to services and data managed by the agencies. Agencies may also serve as brokers or matchmakers, bringing together agents with similar interests and compatible goals, and providing a "meeting point" at which they can interact safely.

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[1] The *shape* of the threshold shown indicates qualitatively that an extreme amount of either agency or intelligence is presumed to compensate for a deficiency in the other dimension.

Mobility brings a host of security, privacy, and management challenges (5). Initially, applications will likely be built around static agents; mobility will appear gradually over time, as the infrastructure for agents matures.

3. Applications of Intelligent Agents

There are many ways in which intelligent agents can be used to benefit users, and the application classification by Janca (3) offers a comprehensive view. For each of these eight application areas, it is important to note *what* user needs the move to network centric computing drives, *how* users will benefit from agent-enhancement, and *examples* of IBM efforts to bring the intelligent agent model to bear on this application area. IBM is currently offering several products which implement intelligent agent function or enable their implementation by developers. In addition, IBM has intelligent agent technologies in various stages of development or research, which are not yet product offerings.

3.1 Systems and Network Management

Systems and network management is one of the earliest application areas to be enhanced using intelligent agent technology. The movement to client / server computing has intensified the complexity of systems being managed, especially in the area of LANs, and as network centric computing becomes more prevalent, this complexity further escalates.

Users in this area (primarily operators and system administrators) need greatly simplified management, in the face of rising complexity. They need mechanisms that will help them cope with continued reductions in information technology spending.

Agent architectures have existed in the systems and network management area for some time, but these agents are generally "fixed function" rather than intelligent agents. However, intelligent agents can be used to enhance systems management software. For example, they can help filter and take automatic actions at a higher level of abstraction, and can even be used to detect and react to patterns in system behavior. Further, they can be used to manage large configurations dynamically.

In addition to extensive use of fixed-function agents in IBM's network and systems management products, IBM offers several products which benefit from intelligent agents. **NetView for AIX Systems Monitor** is a facility that allows events to be intercepted, analyzed according to simple rules, and then handled automatically. Derived events (e.g. based on thresholds or combinations of events) may propagate through a hierarchy of System Monitor events on systems throughout the network. Similar function appears in the **NetView for AIX ESE** (Event Stream Enhancement) function, where policies (rules) govern how events are analyzed and handled. These rules may be entered and edited graphically. Both these offerings make the systems management software easier to operate as complex analysis and handling is delegated to intelligent agents. Additional information on systems management is available at http://www.raleigh.ibm.com/svd/svhome.

3.2 Mobile Access / Management

As computing becomes more pervasive and network centric computing shifts the focus from the desktop to the network, users want to be more mobile. Not only do they want to access network resources from any location, they want to access those resources despite bandwidth limitations of mobile technology such as wireless communication, and despite network volatility.

Intelligent agents which reside in the network rather than on the users' personal computers can address these needs by persistently carrying out user requests despite network disturbances or intermittent connection. In addition, agents can process data at its source and ship only compressed answers to the user, rather than overwhelming the network with large amounts of unprocessed data

IBM **MQSeries** messaging and queuing support addresses the need for reliable, asynchronous program to program messaging. Through a common high-level API spanning 19 platforms, MQSeries lets applications interoperate without having constant connectivity and assures once and once-only delivery across systems and various communication protocols. MQSeries supports disconnected operation for mobile applications via its inherent message queuing model, and the direction is to enhance this support for the mobile and wireless environment.

Additional information about MQSeries is available at http://www.hursley.ibm.com/mqseries.

3.3 Mail and Messaging

Messaging software has existed for some time, and is also an area where intelligent agent function is currently being used to add value. Users today need the ability to automatically prioritize and organize their e-mail, and in the future, they would like to do even more automatically, such as "pulling" messages of interest from a common repository of messages, or even addressing mail by organizational function rather than by person. (These functions are closely related to the area of information access and management; see section 3.4.)

Intelligent agents can facilitate all these functions by allowing mail handling rules to be specified ahead of time, and letting intelligent agents operate on behalf of the user according to those rules.

IBM has several offerings in the messaging area, including **Lotus cc:Mail** and **Notes Mail**. Both cc:Mail and Notes Mail have agent functions: end users can specify rules and personalize the behavior of their mail handling.

IBM **Alter Ego** is a rule-based intelligent agent which can handle mail and other routine tasks. Alter Ego can respond and react to events such as incoming or outgoing mail or time of day.

Alter Ego uses a template-based rule editor to indicate how mail is to be handled in an easy way. Mail is actually handled in the network rather than on the user's workstation. A forward-chaining inference engine supports rules that can classify mail with abstract attributes and then direct processing according to the attributes. The Alter Ego retains a log of activities it has performed to assist the user in verifying actions taken automatically.

IBM is investigating adding adaptive behavior to Alter Ego, so that it can learn and modify rules by observing the user's behavior. A prototype of Alter Ego is available on the Intelligent Agent home page.

IBM recently announced **MQSeries Three Tier,** an enhancement to the MQSeries product described above. This support significantly reduces the amount of application code that has to be written for the *client-agent-server* structures typical of many networked agent scenarios. A proof of concept application is being developed that will show integration of telephony and workflow into the MQSeries Three Tier environment.

3.4 Information Access and Management

Information access and management is an area of great activity, given the rise in popularity of the Internet and the explosion of data available to users. Users need to find the *right* information, and they need it organized in a way that makes it *easy to understand*. Intelligent agents are helping users not only with search and filtering, but also with categorization, attentional prioritization, selective dissemination, annotation, and collaborative sharing.

Intelligent agents can traverse the Internet, corporate databases, and local workstation data looking for data which is of interest. They can do this while running on the user's workstation or on a server in the network, without actually having to "go" anywhere. They can apply sophisticated filters to data to locate just the right information. They can even *learn* what the user really wants to see.

IBM **Activist** monitors the user's web activities and builds a personal profile based on web wandering. The profile can then be reviewed and updated manually if the user selects or it will continue to refine its knowledge of the user interest. When the user returns to his Activist, the user can easily see any changes to the areas of interest identified in his profile. Changes are identified and hot links are provided for easy access to the information. Activist code runs on a server machine with no client code required. It can be used with any browser that supports HTML 2.0. A prototype of Activist is available on the Intelligent Agent home page.

The **Globenet** system developed at IBM Research performs knowledge-based retrieval and handling of newsgroup-like information from heterogeneous WAN sources. Users specify personal, rule-based intelligent agents that control the retrieval and handling done on their behalf.

Globenet plus RAISE (Reusable Agent Intelligence Software Environment) (6) reasons about both structured attributes available from message headers, e.g., author and subject, and unstructured attributes available from message bodies, e.g., free text conditions specified as Boolean expressions in keywords and phrases.

Globenet is currently deployed in a customer service support application within IBM to aid human staff in their answering of customer questions and problems.

Globenet includes features distinctive to customer service support: it automates identification of questions and supports humans' collaboration in the process of query-answering. Early field experience has demonstrated productivity improvements of over 30%.

Another area of information access and management is *navigation*, for which adaptiveness is especially important. **Knowledge Utility** (KnU) is a general purpose hypermedia system offering intelligent information retrieval and management. KnU allows groups of users to weave together all forms of data, connecting knowledge into meaningful patterns which aid users in retrieving appropriate information.

KnU allows an individual to identify interconnections among pieces of knowledge from different disciplines, and leaves a tangible and persistent record of that process of research and exploration. To accomplish this, KnU keeps user-specified relationships between data objects, allowing the users to receive information which is tailored to their interest pattern. Data returned to each user is automatically prioritized based on the preferences *learned* from that user, using Bayesian Networks (7).

The World Wide Web provides connections from within the Internet and remains largely read-only, so no additional connections can easily be made. KnU provides connections into and out of the Internet. Using KnU, users can connect from Internet objects to their own private data and back again, building an important knowledge base.

KnU helps the information overload problem by helping locate information which is truly relevant, and by providing a way to relate that information to existing information in a prioritized way, based upon user preferences. The **Aqui** prototype for Internet information connections is built on KnU; Aqui can be found at http://knuaqui.stllab.ibm.com or on the intelligent agent home page.

The **IBM Neural Network Utility** (NNU), currently available on most popular platforms, is an intelligent assistant for software developers, which offers the pattern recognition and learning so needed for information access. With NNU, the developer can define and graphically connect neural networks, fuzzy rule systems, and data filtering/translation and then embed them into applications. NNU supports on-line learning, controlled by scripts or application programs. NNU can be extended with custom neural network models and custom data filters.

3.5 Collaboration

Collaboration is a fast-growing area in which users work together on shared documents, using personal video-conferencing, or sharing additional resources through the network. One common denominator is shared resources; another is teamwork. Both of these are driven and supported by the move to network centric computing.

Not only do users in this area need an infrastructure that will allow robust, scaleable sharing of data and computing resources, they also need other functions to help them actually build and manage collaborative teams of people, and manage their work products.

Lotus Notes is the premier collaborative software product. The kinds of functions discussed above for Information Access and Management, especially selective dissemination, are very important for collaboration as well. *Notes Agents* allow automation of many tasks within Notes. They operate in the background to perform routine tasks automatically for the user such as filing documents, sending e-mail, looking for particular topics or archiving older documents. They can be created by designers as part of an application to automate routine tasks such as progress tracking, reminders of overdue items, or perform more powerful functions, such as manipulating field values and bringing data in from other applications.

Since an agent typically represents an individual user's interests, collaboration is a natural area for agent-to-agent interaction and communication. IBM is exploring agent interaction through several efforts.

IBM Research has developed an intelligent agent for Lotus Notes that combines rule-based reasoning and scripting, with the goal of automating information dissemination. This extends the approach of Globenet plus RAISE: Notes databases are input and output of the agents. An important goal of this project is to identify a common rule representation scheme and common inference engine interfaces, so that rules can ultimately be shared across software from multiple sources in multiple disciplines, such as scheduling, workflow, and systems management.

Another project is **Object REXX,** the object-oriented successor of IBM's popular REXX Language. Object REXX delivers traditional scripting benefits, facilitating solution building by integrating and managing existing programs, using an interpreted language. Object REXX has been used to prototype collaborative function, and is well suited for it. New functions compared to REXX include standard object oriented features (inheritance, polymorphism, encapsulation, etc.), a rich set of built- in classes, a natural object concurrency model, allowing network centric solutions such as servers, clients, and intelligent agents to be built quickly and easily, plus access to SOM, DSOM, and OpenDoc technologies.

Object REXX is available for OS/2 today, with versions in development for Windows, AIX, VM, and MVS. Demonstrations showcase OREXX "network-agile scripting", including client/server solutions, mobile agents, and dynamic HTML user interfaces. Additional information on Object REXX is available at http://www2.hursley.ibm.com/orexx.

In a third project, IBM is supplying agent technology to the National Industrial Information Infrastructure Protocol (NIIIP) Consortium. This is a group of leading U.S. information technology suppliers and users with a common interest in deploying computing solutions that will make the nation's manufacturing industry more efficient and globally competitive through enabling the "virtual enterprise". IBM's NIIIP Agent Interaction Facility **(AIF)** project constructs virtual "office buildings" which house agencies and agents that can pursue a variety of goals, such as information search and retrieval, change notification, and product pricing. Currently prototyped in Object REXX, the AIF is built on industry-standard CORBA distributed object interfaces and is enabled to use other key NIIIP components, including Internet Connectivity, Work Management / Workflow, and Knowledge Base.

3.6 Workflow and Administrative Management

Administrative management includes both workflow management and areas such as computer/telephony integration, where processes are defined and then automated. In these areas, users need not only to make processes more efficient, but also to reduce the cost of human agents. Much as in the messaging area, intelligent agents can be used to ascertain, then automate user wishes or business processes.

IBM **FlowMark** provides an environment for direct manipulation of graphical objects that define and capture the activity steps that make up any business process (for example, handling a claim, approving a line of credit, or registering a patient). An activity may be automated (carried out by the execution of a program) or performed by a person defined via a registration process. The user defines the process by drawing connectors between the activities, and specifying the rules for when each is to be carried out. FlowMark supports both parallel and sequential activities. The output of one activity step is the input to the next activity step. Once defined, the model can be animated or verified for completeness and correctness.

In this way, FlowMark allows a user to delegate the handling of work; once delegated, the work is managed by the intelligent agent technology in FlowMark. Additional information on FlowMark is available at http://www.torolab.ibm.com/workgroup/flowmark/exmn0mst.html.

3.7 Electronic Commerce

Electronic commerce is a growing area fueled by the popularity of the Internet. Buyers need to find sellers of products and services, they need to find product information (including technical specifications, viable configurations, etc.) that solve their problem, and they need to obtain expert advice both prior to the purchase and for service and support afterward. Sellers need to find buyers and they need to provide expert advice about their product or service as well as customer service and support. Both buyers and sellers need to automate handling of their "electronic financial affairs".

Intelligent agents can assist in electronic commerce in a number of ways. Agents can "go shopping" for a user, taking specifications and returning with recommendations of purchases which meet those specifications. They can act as "salespeople" for sellers by providing product or service sales advice, and they can help troubleshoot customer problems. They can automatically keep track of and pay bills as well as help manage the investment portfolio.

IBM is planning several offerings in the area of electronic commerce.

3.8 Adaptive User Interfaces

Although the user interface was transformed by the advent of graphical user interfaces (GUIs), for many, computers remain difficult to learn and use. As capabilities and applications of computers improve, the user interface needs to accommodate the increase in complexity. As user populations grow and diversify, computer interfaces need to learn user habits and preferences and adapt to individuals.

Intelligent agents can help with both these problems. Intelligent agent technology allows systems to monitor the user's actions, develop models of user abilities, and automatically help out when problems arise. When combined with speech technology, intelligent agents enable computer interfaces to use more human or "social" interaction techniques.

The **COACH** (COgnitive Adaptive Computer Help) (8, 9) system, developed by Ted Selker of IBM Research, models user behavior and uses an inference engine to provide both proactive and adaptive assistance. COACH has been applied to both application-specific environments and general-purpose system interfaces.

Some interface agents use standard (GUI) methods of interacting with users. However, as more natural interaction techniques emerge, more Human-Centered methods of interaction are appropriate for interfaces to agents. Speech recognition, speech synthesis, natural language processing and animated facial images work together to represent agents' states and activities anthropomorphically. As these grow in accuracy and sophistication, they promise to greatly enhance the human-computer interface in general and intelligent agent applications and services in particular.

IBM is doing advanced development on **Conversational Agents**. This work provides a personalized user interface to applications by integrating a variety of human-computer interaction techniques into a single "friendly" interface. Specifically, these agents use a variety of animated forms that respond to user input with text, synthesized voice and visual expressions. Speech and text input is processed by a language parser that takes natural-language phrases and interprets them for cooperative processing by agents. Multiple conversational agents can coexist, performing different functions such as system navigation, mail processing, or telephone use. One of the advantages of this type of agent is that it gives users a familiar and natural way to interact with a system.

4. Vision of Common Architecture

Just as human assistants vary in style and approach, it is expected that intelligent agents will have different styles and approaches. Yet all those agents need to cooperate to get the user's job done, whether the agents are written by the same company, in the same style, or not. IBM's approach is to foster an open environment where the various intelligent agents *can* form a team to assist the user. This approach requires defining an architecture which allows assembly of agents and agent-enabled applications from reusable parts, and participating in evolving standards for agent interaction.

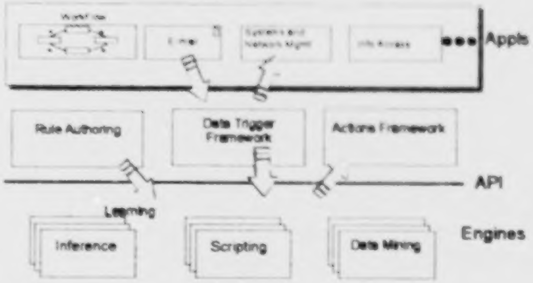

FIGURE 3: AGENT ARCHITECTURE

4.1 Open Components

IBM's agent research and developments are now moving toward an architecture to better integrate and leverage its broad expertise and the resources that have been described in this paper. A *common object model* will allow reuse of any object-to-agent "adapter" developed in one project for the needs of any other project. For example, as shown in Figure 3, the adapter developed for e-mail events and actions could be used with that developed for network management events and actions. This will allow network agents to engage administrative personnel in many more flexible ways. A large set of such object adapters, for data bases, communication services, and personal applications to name a few, form the foundation.

This same principle applies to the other layers of the agent architecture: crisp interfaces into the "engine" layer allow engine offerings (ranging from scripting and inferencing to complex data mining) developed in one project to be plugged into another. Learning engines could contribute automatic rule generation. Classical model/view separation allows a similar choice among user interfaces: rules could be defined using Alter Ego's Rule Template Editor, a graphical rule editor like that in IBM WorkGroup Agent, or natural-language speech processed by conversational technology. The entire set of engines can be applied to end-user events as well as autonomous object events.

4.2 Toward Standards for Agent Interaction

As the number and sophistication of agents increase, so will the need for agents to intercommunicate, collaborate, and negotiate to accomplish their assigned tasks. Such wide-scale interoperability will require open, standard protocols and interfaces. IBM's experiments with knowledge sharing and agent interaction, including the Lotus Notes/RAISE and NIIIP AIF projects described in section 3.5, will provide some of the practical experience essential to crafting sound, workable standards.

The ARPA Knowledge-Sharing Effort offers a promising direction for standardization, through its Knowledge Interchange Format (KIF) (10), Ontolingua (11), and Knowledge Query and Manipulation Language (KQML) (12) components. KIF can serve as a common language for expressing facts, beliefs, and rules. Ontolingua is a system and approach for creating and maintaining domain-specific vocabularies. KQML, a high-level protocol and language for agent-service and agent-agent communications, can wrap KIF or other content languages, transport such messages among agents, and provide semantic routing and brokering.

The Object Management Group (OMG) is preparing to request proposals for standards on agent interaction and rule management interfaces. IBM participated in drafting this request for proposals, and has worked with other OMG members to define a reference architecture for agent interaction (4). As this area evolves, IBM looks forward to collaborating with other members of the Agent community to develop and refine these standards.

5. Conclusion

Intelligent agents are an important part of solving many current problems, including complexity and information overload. These problems are magnified by the advent of network centric computing. IBM has done considerable work in products, advanced development, and research that exploit intelligent agents. IBM is proposing an open intelligent agent infrastructure which simplifies the development and use of agents and promotes cooperation among them. IBM is interested in working with both software developers and other companies to provide needed parts, and together explore intelligent agent applications.

References

(1) Maes P (1994). Agents that Reduce Work and Information Overload, *CACM*, 7, 31-40.

(2) Guilfoyle C and Warner E (1994). *Intelligent Agents: the New Revolution in Software*, Ovum.

(3) Janca P (1995). *Pragmatic Applications of Information Agents*, BIS Strategic Decisions.

(4) Virdhagriswaran S, Osisek D, and O' Connor P (1995). Standardizing Agent Technology, *ACM StandardView*.

(5) Chess D, Grosof B, Harrison C, Levine D, Parris C, and Tsudik G (1995). Itinerant Agents for Mobile Computing, *IEEE Personal Communication Services Magazine*, 5, 34-49.

(6) Grosof B N and Foulger D A (1995). Globenet and RAISE: Intelligent Agents for Networked Newsgroups and Customer Service Support, *Proceedings of the Fall 1995 Symposium on AI Applications in Knowledge Navigation and Retrieval*, MIT.

(7) Fung R and Del Favero B (1995). Applying Bayesian Networks to Information Retrieval, *CACM*, 3, 42-8.

(8) Selker T (1994). COACH: A Teaching Agent that Learns, *CACM*, 7, 92-9.

(9) Indermaur K (1995). Baby Steps, *Byte*, 3, 97-104.

(10) Genesereth M R and Fikes R E (1992). Knowledge Interchange Format Version 3.0 Reference Manual, *Technical Report Logic-92-1*, Stanford University.

(11) Gruber T R (1993). A Translation Approach to Portable Ontology Specifications, *Knowledge Acquisition*, 5(2), 199-220.

(12) Finin T, Fritzson R, McKay D and McEntire R (1994). KQML as an Agent Communication Language, *The Proceedings of the Third International Conference on Information and Knowledge Management*, ACM.

THE POLITICAL ECONOMY OF INDIA'S TELECOMMUNICATION REFORMS

Nikhil Sinha
Assistant Professor
Department of Radio-TV-Film
University of Texas at Austin
CMA 6.118, Austin, TX 78712, USA
(512) 471-6676 (Tel); (512) 471-4077 (Fax)
nsinha@mail.utexas.edu

1. ABSTRACT

The Indian government is engaged in the widespread restructuring of the country's telecommunications sector as part of its overall program of economic reforms. The new telecom policy reflects the government's view that (a) the rapid improvement and development of telecommunications is vital to the success of the wider economic reforms; and, (b) that such development cannot take place under the public monopoly model that has governed the sector since the country became independent. This paper assesses the new telecommunications policy in the context of India's economic reforms. It evaluates the strengths and weaknesses of the government's approach to telecommunications restructuring with respect to the development of the sector itself and the potential contribution of telecommunications to the overall objectives of the reforms.

2. INTRODUCTION

In June 1991, the Indian Government launched a sweeping economic reform program that radically changed the structure of the country's economy. The reforms were initiated in response to the acute fiscal crisis the country faced because of the foreign exchange crunch triggered by the Gulf War. The government used the short-term crisis as an excuse to overhaul the entire economic system in the hope of triggering long-term economic growth.

In May 1994, the government announced that it would liberalize telecommunications as part of the overall economic restructuring underway. The new telecom policy reflected the government's view that (a) the rapid improvement and development of telecommunications was vital to the success of the wider economic reforms; (b) that such development could not take place under the public monopoly model that had governed the sector since the country became independent.

The new Indian telecommunications policy has a number of characteristics that makes it, perhaps, one of the most interesting telecom reform programs in the developing world. It begins the restructuring process by introducing competition in the local loop, breaking from the normal process which begins with the liberalization of long-distance services. It forces Indian and foreign companies to form joint-ventures in order to enter the bidding to provide basic and cellular services. Instead of licensing one or two companies to provide services nationally, the government plans to grant separate licenses for 18 telecom circles holding out the potential for a number of different providers to enter the market. Finally, it avoids privatization of the government PTT which will continue to provide services in head-to-head competition with the private telcos.[1]

This article takes the position that the nature and characteristics of telecommunications reforms in India are best understood in the context of the overall restructuring of India's economy and are conditioned and constrained by the political and economic exigencies within which the reform process is unfolding. Utilizing a political-economy perspective, it assesses the government's new telecommunications policy in relation to the overall economic reforms and identifies the political and economic imperatives that shaped the policy. The first section of the paper briefly describes the government's new economic policies and the second provides a political and economic analysis of the structural, technical, regulatory and service components of the government's new telecom policy.

3. ECONOMIC REFORMS

The years 1990-91 were among the most difficult in India's recent history. After a decade of Congress rule, the opposition National Front party came to power in 1990 with high expectations of setting the country on a new path of social and economic development. But the National Front government collapsed within a year and a stop gap government formed in its wake also fell within a few months. Two successive governments in one year not only caused considerable political uncertainty but also pushed the economy into a downward spiral. The aftermath of the Gulf War further aggravated the country's economic crisis. Foreign exchange reserves dipped to levels below one month of imports, imports exceeded exports by over 50% and the government's budget deficits soared.

When the Congress government under Narasimha Rao was elected 1991, it faced one of the country's most severe economic crises. Spearheaded by Finance Minster Manmohan Singh, the new government's response to the crisis was two-fold. It put into motion a series of steps to overcome the immediate balance-of-payments problem, and it initiated a sweeping set of measures aimed at restructuring the country's economic system by taking aim at those economic policies which it identified as responsible for the deeper economic malaise.

A massive loan from the IMF took care of the immediate fiscal crisis while the government's New Economic Policy (NEP) took aim at the root causes of the problems plaguing the country's economy.

The NEP has five many components:

1. Devaluation: The Rupee was devalued in an effort to increase exports, narrow the trade gap and prevent capital flight.

2. Deregulation: Controls on domestic private industry were dismantled by abolishing licensing requirements, lifting restrictions on capacity and permitting private companies to operate in areas previously reserved for the public sector.

3. Privatization: Privatization has involved a number of different measures including the outright sale of public sector enterprises, offering shares to the public and joint public-private ownership of enterprises.

4. Liberalization: The government has thrown open a number of monopoly or oligopoly markets in both the public and private sector to increased competition.

5. Globalization: Globalization in the Indian context has involved the opening up of one of the most closed economies in the world to international trade and foreign investment. First, trade polices have been revamped to lower or eliminate restrictions, quotas and tariffs on imported goods while providing significant incentives for exports. Second, the terms and conditions of foreign investment have been restructured to attract greater volumes of investment into the country and to encourage foreign companies to relocate productive activities in India.

Critics of the reform movement argued that the decontrol of industry and easier entry of multinationals would hurt the country's economy and weaken its economic sovereignty in the long run. The opposition came from four main sources. Politically, the government was attacked from the right by the Bharatiya Janata Party, which argued that the easier entry of multinationals would hurt domestic industry and from the left by the National Front parties which accused the government of forsaking the country's anti-poverty and income redistribution goals. The government also faced political opposition from within the Congress Party, with some prominent party members breaking away to form a splinter party on the ostensible grounds of opposition to the reforms.

The third wave of opposition came from some parts of Indian industry which, while welcoming the dismantling of the *license raj*, felt threatened by the anticipated competition from multinationals. The fourth important source of opposition were the trade unions. Trade unions have played an important role in slowing a number of the government's plans, including the liberalization of basic services. The particulars of the government's reform measures and, in particular, the scope of the reforms in telecommunications, are a direct outcome of the struggle between the government's objectives and the resistance generated by these three major forces.

4. TELECOMMUNICATION REFORMS

The government's onslaught on the traditional structure of telecommunications in the country was launched after the recognition that a modern telecommunications system was essential to the success of the entire economic reform program. The critical role of telecommunications in the economic reforms was acknowledged in the New Telecommunications Policy Statement released in May, 1994.

"The new economic policy adopted by the Government aims at improving India's competitiveness in the global market and rapid growth of exports. Another element of the new economic policy is attracting foreign direct investment and stimulating domestic investment. Telecommunication services of world class quality are necessary for the success of this policy. It is, therefore, necessary to give the highest priority to the development of telecom services in the country."[2]

The Policy Statement, guidelines issued in September 1994 to implement the policy and the hundreds of clarifications the government has issued in response to queries from potential private bidders, comprise a package of policies and objectives that make-up the government's telecom reforms. Together, they take four main forms: structural reforms; service obligations, technical and equipment requirements, and regulatory reforms.

4.1 STRUCTURAL REFORMS

4.1.1 PRIVATIZATION VS. LIBERALIZATION

The May 1994 Policy Statement begins with a detailing of the poor state of telecommunications in the India: only 0.8 lines per hundred persons (now 1%) less than that of China, Pakistan, Malaysia and a number of other developing countries; a waiting list as large as one-fourth of the installed base of 8 million lines; less than one-fifth of all villages covered by telephone services. It sets ambitious targets for the growth of the sector: telephones on demand by 1997, all villages to be covered by 1997; and a public call office (PCO) for every 500 persons in urban areas also by 1997. Given the rapid growth of demand that is forecast by the government, the policy document estimates that an additional $7 billion will be required by the end of the 8th Five Year Plan period in 1997. The inevitable conclusion generated by these numbers is spelled out baldly:

"Clearly this is beyond the capacity of Government funding and internal generation of resources. Private investment and association of the private sector would be needed in a big way to bridge the resource gap."[3]

But the policy document also makes very clear that "Private initiative would be used to complement the Departmental efforts" to raise additional resources and provide services, not to supplant it.[4] In short, the policy rules out the privatization, either full or partial, of the Department of Telecommunications (DoT). Privatization, as commonly used, refers to the "transfer of ownership and control from the public to the private sector, with particular reference to asset sales."[5] But the government chose to stay away from this course of action, for good reasons.

At the most elementary level, none of the preparatory work that makes privatization successful had been conducted. Corporatization, the process of converting a government department into a public sector enterprise (PSE), which is usually the first step in the privatization process, was largely incomplete. It is doubtful that without further corporatization an attempt to privatize DoT would have been very successful.

More broadly, there is considerable evidence that ownership changes are rarely appropriate instruments with which to improve economic activity in developing countries, whether they come in the form of nationalization as they did in the 1950s '60s and 70s, or of privatization as in recent years.[6] In economic terms, privatization is unlikely to generate major gains in efficiency, unless it is accompanied by other reforms, such as liberalization which increases the number of service providers in that sector. In most developing countries, India included, the distinction between public and private enterprises is blurred, at least insofar as performance is concerned. The incentives to engage in rent seeking, corruption and patronage, which came to characterize both public and private enterprises in India during the period of the *license raj*, is linked more to the fact that there was no competition and less to the pattern of ownership.

If privatization has little economic impact, the political, ideological and symbolic impact of privatization may have been disastrous for the government. The Rao government had to act in a way that the reform process would be politically acceptable and would not threaten the viability of the government itself. This has not been easy. The government had already experienced electoral defeats in key states and the opposition parties have made the government's economic reforms a major electoral issue. Ideologically, the government was faced with the long-standing suspicion of private industry, particularly multinational corporations, bred during the 40 years of socialistic policies. While privatization may have been easier to push through for loss-making PSEs operating in the consumer goods sector, to do so in a highly visible infrastructure sector like telecommunications was fraught with political consequences that the government could not ignore.

Nor was the government prepared to deal with the fall-out of selling one of the country's largest employers. The DoT employs 450,000 unionized workers and its employees are represented by some of the strongest trade unions in the country. Even without privatization the unions have been a major stumbling block in the government's efforts to restructure the sector. A nationwide strike in June 1995, coupled with an appeal to the country's courts, almost prevented the government from opening the tenders that had been submitted by private telcos for cellular and basic service licenses. The government has been at pains to placate the trade unions. Communications Minister Sukh Ram has publicly announced that a substantial part of the Rs. 100,000 crore (US$ 30 billion) the DoT hopes to generate through license fees and revenue sharing over the next 15 years will be used to upgrade the manpower skills and undertake welfare programs for its employees.

Rejecting privatization as a viable policy option, the government chose to attract private investment into telecommunications by allowing private companies to provide cellular services and, more dramatically, basic telephone services across the country. The 1994 Policy Statement and the guidelines that were issued to implement the policy stipulated that private companies would be allowed to provide basic services in competition with the DoT. Only companies registered in India were permitted to apply for licenses. By stipulating that potential bidders were required to have a track-record of having run a system of at least 500,000 lines for five years, the government virtually forced Indian companies to enter into partnership with foreign telcos. But the government also limited foreign participation to 49% of the equity holding of the joint-venture company. The government divided the country into 18 circles (20 for cellular services), each more-or-less corresponding to a State boundary, and invited separate bids for each of the circles. By stipulating that only one private company would be licensed in each circle the government set-up a duopolistic market structure in each of the circles with the private telco competing head-to-head with the DoT for providing fixed basic services. In cellular services, two private companies are to be licensed in each circle. All the private companies are to be licensed for 15 years (10 years in the case of cellular operators) but they have been kept out of the long-distance (international and inter-circle) market for at least five years, with the government committed to reviewing that decision at the end of that period.

4.1.2 FOREIGN VS. DOMESTIC OWNERSHIP

The particulars of the liberalization policy reflects the diverse economic and political objectives the government sought to achieve. It also reveals some of the major problems in the government's approach. The government's decision to allow foreign telcos to participate in the licenses appears to have been motivated by three main considerations. First, it was evident that by themselves domestic companies would have considerable difficulty in raising the huge investments involved. Nor would the domestic and foreign capital markets be very interested in investing in these projects without some foreign participation, since no private company in India had any expertise in the area. This lack of experience also made the government uncertain of the ability of domestic industry alone to deploy the technology and run the service. Second, forcing domestic companies to tie-up with foreign telcos, contributed to the government's' overall design of encouraging FDI into the country. By current estimates, the 20 or so foreign telcos that have partnered with Indian companies to bid for cellular and basic service licenses will invest about US$ 5 billion into the country over the next 10 years. Finally, foreign participation was encouraged to achieve the technological leap-frog that would be needed to build a world class telecommunications network.

But while encouraging foreign participation was important, the government also had to involve domestic industry in the reform process. Politically, the government has sold liberalization to the public and to Indian industry by limiting the extent of the participation by foreign companies in Indian enterprises. Very few foreign companies have been given permission to set-up 100% owned ventures in the country and even 51% ownership has been limited to a select list of high priority areas. Not only has the government been faced with the political objections to liberalization from the country's opposition parties, it has also had to deal with complaints from Indian capitalists that the reform program threatened the viability of Indian industry. Organized objections have come in the form of the so-called "Bombay Club," a group of industrialists who came together to oppose the government's opening up of the economy. By forcing the multinationals to partner with Indian companies, the government disarmed many of the objections of both the political and industrial opposition. Though there was considerable internal debate within the government on whether or not foreign telcos would be permitted to own 51%, the political imperatives of being able to successfully push through reforms in a highly visible sector like telecommunications made limiting foreign companies to minority positions was virtually inevitable.

Limiting the extent of foreign ownership also made good fiscal sense in an economy facing a severe foreign exchange crisis. Though by the time telecommunications came under the ambit of the reforms the exchange crisis had eased considerably, the overall purpose of the reforms was to ensure that foreign exchange levels never again fell to such dangerously low levels as in 1991. The extent of foreign equity holding in a domestic company determines the outflow of foreign exchange in the form of dividends and capital gains. In sectors which have the potential to generate significant export revenues, the extent of foreign ownership may not be a problem, as long as the extent of the investment and the export revenues exceed the outflow. But in local telephony, with no chance of export revenues, the government's cap on foreign ownership also ensured that the amount of foreign exchange generated through foreign investments in the sector would out-pace the extent of outflows for a considerable period of time.

4.1.3 BASIC VS. LONG-DISTANCE SERVICES

The decision to liberalize local services rather than the more attractive long-distance services was one of the most controversial decisions of the reform process. Both within the government and in outside agencies like the World Bank, there was the conviction that opening up basic services would not attract the private investment necessary to jump-start the reforms. Indeed, many of the U.S. Regional Bell Operating Companies (RBOCs) stayed away from the bidding partly because the short-term profitability of the licenses for basic services was far from apparent. However, the fear that foreign telcos would stay away from the bidding in large numbers has turned out to be largely with, about 20 foreign companies bidding for licenses for both cellular and basic services with their Indian partners. The financial bids, for cellular and basic services, have been very high with the government standing to earn US$ 45 billion in license fees alone over the next 15 years.

By liberalizing local rather than long-distance services, the government disarmed potential criticism that it was selling-out profitable services to private capital. By holding out the prospect that the private telcos would be allowed to provide long-distance services after five years, it held out the promise of significant rewards for the private telcos in the long-term. And the decision also reflected the demands of both infrastructure development and economic development. India's principle sectoral problem is its low telephone density (at 1% lower than most other developing countries) and the large unmet demand for telephones reflected in the long waiting list for phone connections. In the 1994 telecom policy statement, the government set an ambitious set of targets to be achieved through the reforms: telephones on demand by 1997; all villages to be covered by 1997; at least one PCO for every 500 persons in urban areas and an additional 2.5 million lines to be installed by the end of the VIII Plan in 1997. These targets could only be met through massive investment in the expansion of the *basic* network.

But if liberalizing only basic services solved one set of problems, it also raised another. Expanding the basic network without corresponding increases in the capacity of the long-distance network holds out the possibility of increasing grid-lock on the long-distance network with rising call congestion and lower call completion rates. The extent to which the government is serious about allowing the private telcos into the long-distance market after five years is uncertain. However, it will have to take serious measures to expand the capacity of the long-distance network before too long, or it may well choke because of the rapid growth of the basic network.

4.2 SERVICE OBLIGATIONS

4.2.1 CIRCLES VS. NATIONAL LICENSES

The government sought to ensure that the expansion of telecommunication and the development of the national network expansion took place in an uniform manner across the country and that the interests of more or less industrially advanced states and of rural and urban areas were evenly balanced. Since nationwide private providers could be tempted to cream-skim, investing only in urban areas or in states with high potential returns, the government decided not to license any national service providers, but rather broke up the national service areas into 18 circles roughly corresponding to state boundaries.[*] This ensured that poorer states like Uttar Pradesh or Bihar or the north-eastern states like Manipur, Mizoram or Arunachal Pradesh, which already suffered from very poor infrastructure, would not be neglected. The government hoped that it would also ensure that there was no political or electoral backlash against the Congress Party in these states. The circles approach made good fiscal sense, since the combined revenues generated from competitive bidding in each of the circles would probably be higher than those generated from a single national auction. It would also force the telcos to select competitive technological solutions and roll-out plans based on the unique characteristics of each market.

The circles were divided into A, B and C type circles according to the estimated size of the market for telephone services. Initially, bidders for A category circles were also required to bid for circles in the other two categories but the government shelved this plan due to protests from potential bidders and out of the fear that it would scare many of them away. In the end it simply asked for individual and independent bids for each of the circles. The government's plan has been only partially successful. While the overall number of bids for both cellular and basic services have been high, some circles, like the Jammu and Kashmir circle received no bids[9] for either basic or cellular services and the Andaman and Nicobar Island circle received no bids for cellular services. Five circles have received only one bid for basic services and another four received only two bids. At the other extreme a single consortium has emerged as the highest bidder to provide basic services in 9 circles. If the bids are allowed to stand, the government runs the risk of granting significant market to a single operator. A final picture will emerge only after government takes a decision on whether to cap the number of circles within which a company may operate.

4.2.2 RURAL SERVICES

Along with balanced regional development, the government also sought to ensure that the private telcos invested in the expansion of the rural network. It mandated that 10% of all new lines should be installed in rural areas and all villages should have access to at least a PCO by the end of 1997. In addition, 15% of the weight for the evaluation of the bids for basic services would be based on the number of lines in rural areas a company committed to install in excess of the mandatory 10%.

The emphasis on rural expansion clearly had a strong political component to it. It not only deflected the charge that the government's policies were pro-rich, it also provided a shield against accusations that the government was allowing the private telcos to engage in cream-skimming. But the emphasis on rural expansion was also an important part of the government's larger economic objective of promoting the accelerated development of industrially backward areas. The government has not been very successful in attracting investments to rural areas primarily because of the lack of adequate infrastructure facilities. By forcing the telcos to commit to expanding their networks into rural areas, the government hopes to overcome one of the main bottlenecks in the industrialization of rural and backward areas.

4.3 TECHNICAL REQUIREMENTS

4.3.1 NETWORK ROLL OUT

Given the ambitious targets the government set for the expansion of basic services in the Policy Statement, it has put great emphasis on the speed with which the licensees roll-out their networks. Ten per cent of the weight of evaluating the bids is to be given to the number of lines the bidders commit to install during the first three years. The government has announced that it will penalize the licensees Rs. 11 (approx. US$ .30) per day for every line short of their commitment. By placing such emphasis on the pace of the network expansion, the government hopes that quick results, like the reduction of waiting lists, will blunt criticism of the reforms and generate for it some political capital as well.

4.3.2. LOCAL EQUIPMENT

The government's approach to equipment and technical issues also reveals the same dual purpose approach that, on the one hand, attempts to counters political opposition and, on the other, pushes forward its economic objectives. Faced with the criticism that the introduction of foreign private service providers into the sector would undermine the domestic telecommunications equipment industry, the government assigned 3% of the weight for the evaluation of the basic tenders to the use of indigenous equipment. Here too the government has announced heavy penalties if the licensees do not keep their commitment to buy indigenously.

But the definition of what constitutes indigenous equipment has been changing under the government's liberalization policies. In 1992, the government allowed foreign companies to enter the equipment manufacturing sector, allowing them to own up to 51% of joint ventures in the area. Since then AT&T, Siemens, Alcatel, Fujitsu, Ericsson and GPT have set up domestic manufacturing enterprises. The decision to allow foreign equipment manufacturers into the small-switching systems business was especially difficult, considering the government's commitment to developing indigenous technology and protecting local industry. It was fiercely resisted by the Telecommunications Equipment Manufacturers Association (TEMA) which called for severe restrictions on the entry of the foreign companies. It also called into question the future of the government's R&D wing C-DOT (Center for the Development of Technology).

But by encouraging the licensees to install domestically manufactured equipment and by allowing the world's leading telecom equipment manufacturing companies to set up shop in India, the government hopes to establish an internationally competitive telecom equipment manufacturing industry. It hopes that the private telcos will bring in the equipment manufacturers on their coat tails.

4.4 REGULATORY REFORMS

Perhaps the most contentious aspect of the government's plans, and the one issue the government has handled rather poorly, is that of regulating the new telecommunications environment. Prior to the new policy, the DoT had combined the roles of service provider and regulator, and initially it appeared that it would continue to exercise the regulatory function despite its very clear conflict of interest. This was partly the reason why a few of the U.S. RBOCs were reluctant to participate in the tenders. After intense lobbying from both Indian and foreign companies and the U.S. Commerce Department, the government announced that an "autonomous" three member Telecommunications Regulatory Authority of India (TRAI) would be set up which would be empowered to set standards, regulate prices, ensure technical compatibility among the different service providers, develop revenue sharing arrangements, fix access charges, enforce service requirements and resolve disputes among service provides. However, the government resisted setting up TRAI as a statutory body, which would have put it on par with such independent bodies as the Election Commission or Finance Commission. This again raised the specter that TRAI's decision would be subject to interference and manipulation from the government.

Eventually, the government compromised its control over TRAI by agreeing to vest it with the powers and protection of a statutory body without actually writing the powers into a new law. The government passed a one-line amendment to the Indian Telegraph Act of 1885 allowing it to set up TRAI. But during the passage of the bill the Government assured Parliament that it would have no authority to override TRAI's decisions, even though the watch-dog body would be of a non-statutory character to start with. It pledged that the orders of the TRAI would only be challenged before the High Courts or the Supreme Court and would not be subject to review by any executive body. Nor would the decision of the TRAI be reversible by any arm of the government including the Cabinet.

During the debate on the amendment in Parliament, the government attempted to send a strong signal to the private telcos that TRAI would "act independently, impartially, in an objective manner to protect the interests of the private operators as also of the subscribers."[10] Though the TRAI would be of non-statutory body to start with, officials of the Communications Ministry told Parliament that the government would like the body to be autonomous in "due course... after a year or two," based on how its functions.[11]

Despite the governments reassurances, a number of key regulatory issues remain unresolved. What will be the revenue sharing arrangements between the telcos and DoT? How will TRAI resolve inter-connection and network management disputes? How insulated will it be from the entrenched telecom bureaucracy? Will it be strong enough to handle both the trade unions and the private telcos? The success of the entire reform process may well depend on the effectiveness of TRAI and its functioning will be closely watched.[12]

5. CONCLUSIONS

A country's economic policies reflect a mix of imperatives that flow from the institutional matrix of its politico-economic system. This matrix consists of the formal structure of its political and economic systems and the informal ideological and economic climate within which they operate. Policies which are initiated in periods of transition often reveal a compromise between existing and emerging institutional structures. India's efforts to restructure its telecommunications system are best understood in the context of the larger economic institutional transition initiated by the Narasimha Rao-led Congress government over the past four years. This transition has sought to transform the basis of economic planning and policy making in the country from a model based on limited private and foreign investment, widespread public sector infrastructure development, import-substitution and restrictive trade regulations to one based on private sector-led growth, stepping up foreign direct investment, export promotion and a liberalized trading regime. It also makes a significant break from the socialistic rhetoric that has provided the ideological underpinnings of much of the country's economic planning since its independence.

The telecom reforms provide evidence of the difficult compromises the government has had to cobble together as it seeks to manage the overall institutional transition of the country's economy. They represent an obvious compromise among the various political, economic and bureaucratic interests within the telecom arena. These include multinational corporations, domestic private sector companies, local equipment manufacturers, DoT's 450,000 unionized workers, and the nearly five million current or anticipated consumers waiting for a phone connection. It also represents the compromises the government has had to make to prevent opposition parties making the reforms a political issue and ensure that the new policies do not hurt its electoral chances.

Based on the presumption that a world class telecommunications system is critical in achieving the overall goals of the new economic policy, the government has set a series of ambitious targets for the growth of the sector over a three to five year period. Liberalization of basic services and the decision to allow private companies, in partnership with foreign telcos, to provide services in competition with the DoT are expected to provide the structural, fiscal and technological engines required to arrive at those targets. The decision not to privatize, or even corporatize the DoT, maintaining DoT's monopoly over long-distance services and limiting the extent of foreign participation provide evidence of the government's continued sensitivity to making the reforms politically palatable as well as its inability to fully free itself from the economic nationalism which has guided past policies.

The first phase of the reform process, leading up to the submission of bids for licenses to provide cellular and basic services, appears to have been reasonably successful. While some circles have not attracted more than one or two bids, others have attracted dramatically high bids. The outcome of the next phase of the reform process, the setting up and functioning of the TRAI and the formulation and functioning of guidelines for network management, inter-connection and technical compatibility, rate-regulation and revenue-sharing, and enforcing the "universal service" provisions of the licenses, is very much in the balance. A lot will depend on how India's political and economic institutional matrix adjusts to the transition from a state-dominated to a market-dominated economy. In particular, the speed and impartiality with which the country's judicial system will move to enforce and protect contractual obligations and the extent to which TRAI can function as an independent and impartial arbiter of conflicting claims will be essential in determining the success of the reforms in the long run. The reforms also have to stand the test of political transitions, particularly if one or a coalition of opposition parties come to power in next Spring's general elections.

6. ENDNOTES

[1] The DoT will be required to provide interconnection to the private telcos, which is unlike the Mexican situation where Telex was not required to interconnect thereby killing any potential for real competition. In fact, not only will DoT be required to interconnect, it will also be required to share its existing assets and infrastructure with the private telcos at a reasonable charge.

[2] *National Telecom Policy 1994*. Ministry of Communications, Government of India, New Delhi.

[3] *National Telecom Policy 1994*..

[4] *National Telecom Policy 1994*..

[5] Hemmin, R. and Mansoor, A. "Privatization and Public Enterprises." Occasional Paper No. 56, International Monetary Fund, Washington, D.C., 1988.

[6] See for instance N Van de Walle 'Privatization in Developing Countries: A Review of the Issues' *World Development* 17 (5) 601-615.

[7] *Only privatization can bring funds, says Sukh Ram*. The Economic Times, June 7, 1995, p. 4.

[8] A model not dissimilar to the LATA system which was established in the wake of the break-up of AT&T in the U.S.

[9] No doubt because of the terrorist activity that has engulfed in the State in violence for the past three years. Presumably, the government will reopen bids for the circle once the situation has stabilized.

[10] *TRAI to have statutory powers*. Business Times, August 7, 1995, p. 1.

[11] Quoted in *TRAI to have statutory powers*. Business Times, August 7, 1995, p. 1

[12] For a detailed analysis of the importance of regulatory mechanisms determining the success of telecommunications reforms in developing countries, see the author's chapter "Telecommunications Regulatory Reform in the Third Word: an Institutional Perspective" in B. Mody, J. Straubhaar and J. Bauer (eds.) *Telecommunications Privatization in the Third World & Eastern Europe*. Lawrence Erlbaum, Newbury Park.

The Indonesian Approach to Developing an Information Infrastructure for the coming Multimedia Age

Aviadi H. Purnomo and Indra Utoyo
PT. Telekomunikasi Indonesia
Bandung, Indonesia

1. ABSTRACTS

Indonesia, which has diverse economic activities at different levels, requires a diverse information infrastructure ranging from simple POTS to advanced broadband multimedia services. Just as in many other countries with an information-based economy, the demand for multimedia services is growing rapidly and becoming increasingly integrated into the global market. Indonesia is continuing to evolve and modernise its information infrastructure from N-ISDN toward B-ISDN based on ATM. There will be a precursor step before B-ISDN called Wideband(W)-ISDN which provides SMDS for the metropolitan area network based on technology standard IEEE 802.6 DQDB. This step is an intermediate solution before public ATM is ready for the market. Partnerships and market innovation which is sensitive to customer requirements would be suitable solutions for introducing broadband multimedia.

2. BACKGROUND

Indonesia, a country of endless diversity in almost every aspect of life, is now moving towards the era of world-wide free-trade. The complexity of the country, as it approaches this new period, is indeed astonishing. Indonesia consists of an archipelago of 17,508 islands, inhabited by people of diverse races, cultures, languages and religions. Its citizens number more than 190 million, making it the fourth largest country in the world in terms of population.

Before the mid-1980s Indonesia relied totally on oil, timber and agriculture for export income; at the height of the oil boom in 1982 over 80% of export revenue was derived from oil and 70% of government revenue came from oil and gas. However, in 1985 the world oil price plunged. As a result, the country's major source of income has been changing from agriculture and natural resources to manufacturing and the production of non-petroleum goods. This change has increased the annual economic growth over the last two years to 7%.

In the next century the speed of information, its accessibility and its myriad uses will bring fundamental changes to the economy of every nation. The following examples will show what kind of fundamental changes are likely to occur.

- The United States has taken action to make sure that its industry can take advantage of the economic opportunities offered by the information age, both through the NII Act of 1993 and through announced government spending commitments. The US has been concentrating on ways of deriving benefits from broadband technology and its new applications which will improve efficiency in many fields, from manufacturing to retailing.

- Japan is currently extending fiber to the homes, businesses and institutions of the nation, a process to be completed by the year 2005. A Japanese government report last May emphasized that the information highway can be crucial for Japan in reversing the growing problem of urbanization, a problem faced by most major cities in Indonesia as well as those in many other countries.

- Singapore is well advanced in making the information highway accessible to a large proportion of its citizens. Interestingly for a relatively small state, Singapore has placed emphasis on using technology for distance learning and distance training for its workforce. It has also provided an advanced information infrastructure, which will serve to enhance the competitiveness of Singaporean companies and will encourage overseas companies to locate value-added activities in Singapore.

- The European Union considers the information highway as fundamental in achieving its goal of political and economic integration

These examples are just a few from a long list of countries which are making the transformation to an information-based economy

In Indonesia, a proper strategic plan for developing both telecommunications and an information infrastructure will play a key role in assisting our rapid economic growth, which has recently reached the early to middle stage of industrial development with an average annual per capita income between $300 and $1200.

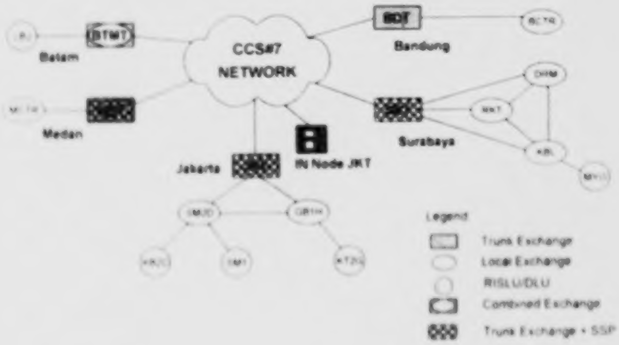

Figure 1. Indonesia Existing N-ISDN and IN

The convergence of technology and the development of the information infrastructure is not just a complex network of networks connecting regional, national and international information infrastructures across the world. It is also a means of integrating the telecommunications infrastructure (telephones, cables, wireless systems etc.) with computers and computer applications which process audio, video and textual information in the form of multimedia applications. If the forecasts are correct, multimedia traffic will appear in enterprise applications (such as cad-cam, super high definition, image transfer, high-speed computer communications and so on) and residential applications (such as on-line home shopping, electronic libraries, video on demand and so on). In planning the infrastructure we should identify and define which multimedia services should have priority. In assigning priorities to multimedia services it will be necessary to consider the prospective market demand along with other aspects such as demographic changes and the rate of economic growth.

3. MARKET DEMAND IN INDONESIA

Over the last five years data communication in Indonesia has grown swiftly; the use of personal computers has grown at a rate of 12.6% per year while the sales of LAN equipment have risen by 15%. Most of the standard systems are equipped with video compression such as MPEG, following a substantial leap in video conferencing technology which has brought better image quality at an affordable price. In addition, Windows-based applications are becoming more hypermedia based and supplying interactive applications in LAN.

A discussion of the information infrastructure leads us naturally on to the Internet, which is now in effect a global networks of networks connecting more than 59 countries, at least five million computers and an estimated twenty to thirty million users. The Internet is growing at rate of 10 to 15 percent a month, or in other words a network is connected to the Internet every thirty minutes [1]

According to data released in 1995, there are five Internet access providers in Indonesia, namely IPTEKNET (for research and development and education), RADnet, Sistelindo and IDOLA
A total of 108 major nodes are operating in Indonesia. Of these, 87 nodes have access to leased lines, dial up links or inter-city or inter-

regional links by satellite which can reach the various Internet gateways.

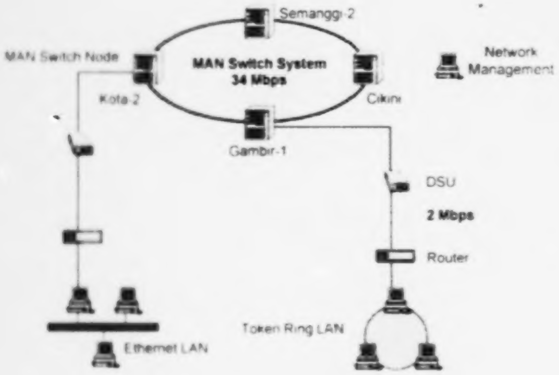

Figure 2. MAN-SMDS field trial configuration

The rest of the nodes, which are mostly in eastern Indonesia and in other remote areas, rely on the radio network. The total number of users is estimated to be 10,639 of which 29.5% are at universities, 5.8% at research institutions, 1% in non-governmental organizations and 42.8 % in commerce or industry. Approximately 71.7% of users are in Jakarta and 25.7% in Bandung, followed by other major cities like Surabaya, Medan, Ujung Pandang and Batam.

4. INFRASTRUCTURE DEVELOPMENT PLAN

Indonesia, whose rapid and continuous economic growth is based on market economics, is actively modernizing its network infrastructure in line with our national program to develop our NII, which is the Indonesian language is known as INFONAS.

At present, TELKOM INDONESIA is Indonesia's major telecommunications provider, with a revenue of more than four trillion rupiah in 1994 and a growth rate of 25% per annum. The latest projections indicate that by the end of PELITA VI a total of 9.8 million line units will be serviced, which is evidence of tremendous growth. In view of this projected growth, TELKOM has committed itself not only to continue new infrastructure development with more telephone lines, but also to develop the future Indonesian Information Superhighway. This highway will help speed Indonesia's transformation into a global information society. This transformation began in 1995, when the pure telephone network (PSTN) became a 64 kbps infrastructure. Implemented in the five major cities of Jakarta, Surabaya, Bandung, Medan and Batam, this infrastructure allows narrowband ISDN services of up to 128 kbps.

These ISDN services will certainly contribute to the development of an information-based economy and society in Indonesia, a goal that should be accomplished by the year 2000 at the latest so that we can compete with other economies on a global scale.

Intelligent Network (IN) services will also be inaugurated at the beginning of 1996. In the future, IN will become a flexible and network-independent platform for the rapid introduction and provision of new, advanced services which can handle more complex calls such as multimedia conferences.

The existing N-ISDN and IN configuration is shown in Figure 1.

Responding to the needs of TELKOM's corporate customers, especially in Jakarta and other major cities in Indonesia, a pilot metropolitan area network (MAN) offering SMDS (switched multimegabits data service) was started in 1995 as a first step toward the development of broadband (B)-ISDN in Indonesia. The technology standard used for MAN SMDS is based on IEEE 802.6 standard DQDB (Distributed Queue Dual Bus). This will be the intermediate step before public ATM is ready commercially and technically approved. The pilot configuration can be seen in Figure 2.

Compared to some other telecommunications companies in Asia, TELKOM is relatively very progressive in modernizing its transmission network. SDH technology and optical fiber are employed in the long-distance network, both in submarine as well as in terrestrial systems, and in the trunk network in Jakarta and Surabaya. The introduction of fiber technology in the access network is also starting this year in thirteen high-rise buildings in Jakarta. Such experience will enable the process to continue even faster in the future.

It is expected that before the turn of the century in major cities in Indonesia, especially Jakarta, TELKOM's network will be ready to offer advanced broadband services for business customers such as CAD/CAM utilization, joint editing, teleworking, medical imaging, and services for residential customers covering video on demand, teleshopping, interactive games, electronic yellow pages and so on.

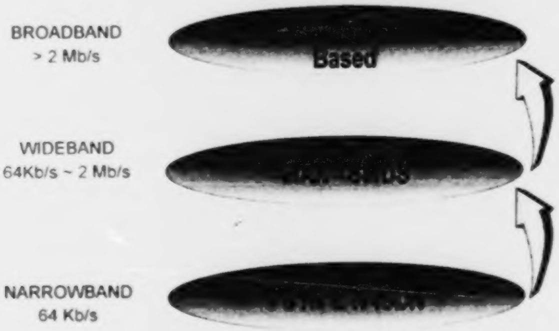

Figure 3. Information Infrastructure Evolution

The introduction of new network technology and new services using broadband technology will follow a path which will be based on market demand and the level of competition.

We can identify various areas where potential future demand for telecommunications is likely. First, Indonesian travel is one potential market since economic activity throughout the huge archipelago is quite phenomenal. Besides, traffic jams in the big cities cost our economy a lot of money. Videotelephony and teleworking are expected to be an economically-viable alternative to business traveling. As for tele-education, a big customer for this is likely to be education and business training, especially in view of the government's plan to develop the human resources of Indonesia over the next 25 years. Home entertainment for the public, such as video on demand, will also very soon become a major development target.

The National Information Infrastructure (INFONAS) multimedia base can also facilitate health care through telemedicine, which links a rural physician to major medical facilities for off-site consultation on difficult diagnoses. Provided that a computer and wireless link are available, it is possible to conduct a database search and to question an expert or consultant. If fiber optic networks are available then telemedicine services can include remote visual examination.

INFONAS can transform education with computer-based multimedia systems that teach with both video and sound, greatly increasing retention rates and offering children wider educational opportunities. INFONAS can also make factories more efficient, speed the creation of new and better goods and services, cut the cost of business by improving efficiency, develop new jobs and markets, increase trade and facilitate the flow of information.

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It should be noted that in the development of TELKOM's future network a high priority will be given to network management and network manageability. TELKOM's network should adopt a simple structure with a small number of network elements in order to gain improved manageability. At the same time, a Modern Management Network System will improve TELKOM's competitiveness. As further development of the infrastructure continues, the Internet with its multimedia service is becoming a reality in our daily lives in Indonesia. TELKOM has sponsored the establishment and further development of a research network which links the National Research Board, the Indonesian Science Institute, ITB, TELKOM's research and development division (DIVRisTi) and TELKOM's university (STT TELKOM).

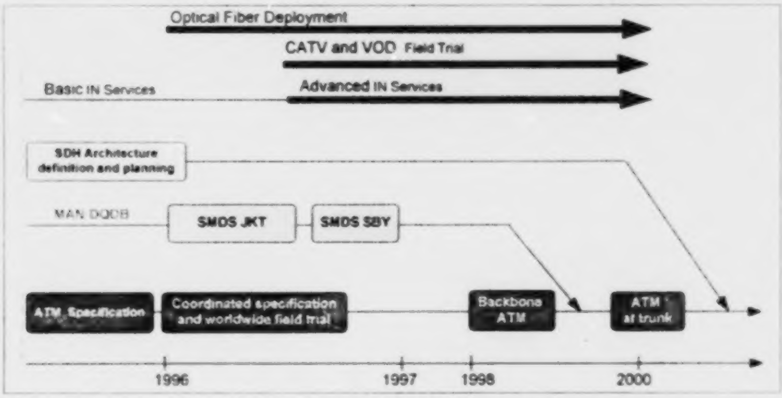

Figure 4. Infrastructure Development Plan

Just like any other telecommunications company, TELKOM will not enter the manufacturing sector, but will focus on developing multimedia software and applications in line with its aim of shifting from "provider-offered services," which emphasize networks, to "customer-selected services," that center on user systems.

5. STRATEGY OF IMPLEMENTATION

5.1. Strategic Alliances

The collaboration and alliance with other operators and vendors according to their experience and competence will be an suitable way of developing the infrastructure effectively and efficiently.

5.2. Access Network Development

Most of the existing subscriber loops use copper cable of various qualities. It is known that several multimedia services of a marginal quality can be applied in narrow band services. However, new services require more bandwidth. This requires a mixed approach to resolving access network shortage. The interim solution which TELKOM will use is common compression coding technology such HDSL and ADSL to improve the capacity of copper cable, although only copper cable with good quality can be used for this. At the same time, TELKOM's principal solution is to install optical fiber in the loop (FITL), starting in January 1996.

5.3. Skill and Human Resources

Clearly, the introduction of so many new telecommunications technologies has a lot of implications. It is inevitable that communication and computing will converge, the boundaries between the two technologies are already blurred. There is, moreover, a clear tendency towards the dominance of the software content of products and services. Possibly even more important that the technology itself is the complex management which is needed in the area of both products and services.

In the multimedia era it is clear that TELKOM employees need to acquire new skills, such as the ability to create new software, market new software-based applications, and be responsive to customer needs.

5.4. Pooling of national potential resources

If we want our economy to stay competitive in this new era of liberalized trade then we have to pool all national potential resources. In other words, there must be collaboration between financial institutions, manufacturing and service industries, research and development bodies, government departments and other institutions which have a common interest.

5.5. Educating the customer in broadband

Educating the customer does not simply require us to explain the new technological acronyms. Far more importantly, we must show how the technology will be converted into services which provide a real competitive edge and hence greater value. Field trials involving real customer traffic, such as the MAN-SMDS field trial in Jakarta and possible future trials of an ATM-based backbone, are two approaches to educating the public about the information superhighway. For people in Indonesia, the real benefit of multimedia services is less obvious than the benefit of POTS. By educating the customers, we can create a demand for new services such as multimedia communications.

6. CONCLUSION

Developing an information infrastructure for the coming multimedia age requires a variety of approaches. The diversity of the people and the imbalance of economic development in which most activities are still concentrated in a few major cities, mean that the market is divided into a series of distinct segments, each with its own particular characteristics. As network provider, TELKOM will continue to modernize the infrastructure, evolving from N-ISDN to W-ISDN then finally to B-ISDN. The main bottleneck in the infrastructure is the access network; its replacement with fiber technology will start in 1996. Collaboration, meaning collaboration between our leading national institutions, is the key word as we strive to accomplish our plans for a national information infrastructure.

References

[1] I. Sudarwo, "The Role of Information Network in Industrial and Science and Technology Development", *paper for Industry and Technology Dialogue*, National Research Council, Jakarta, 8 August 1995.

[2] L.S Harms ed., "Telecommunications and the Travel Industry: Impact on National and Regional Development", Papers from the PTC Mid-Year Seminar Bali-Indonesia, Pacific Telecommunication Council, May 1991.

[3] Syahrir, *Analisis Ekonomi Indonesia di tengah Ketidakpastian*, Gramedia, Jakarta, 1995.

The Pacific Islands Telecommunications and Information Infrastructure Leap-frog or Widening Gap?

Norman H. Okamura* and Edmond Durand**

*Associate Specialist, Social Science Research Institute, University of Hawaii, USA
**Director, Telecommunications Division, Forum Secretariat, Suva, FIJI

1. ABSTRACT

This paper explores the telecommunications and information infrastructures of the microstates of the Pacific Region and analyzes its implications for the ability of these countries to participate in the emerging Global Information Infrastructure (GII). Specifically, this paper explores the question of whether the recent telecommunications developments will enable Pacific Islands countries to "leap-frog" into the GII or whether narrowband networks and services will continue to be the dominant but "backroad" GII interconnection for the Pacific Region.

2. INTRODUCTION

There is considerable dialogue in developed countries about the ongoing convergence of computing, communications, and entertainment technologies, and the development of "National Information Infrastructures" (NII). These discussions often focus on the continuing revolution in telecommunications and information technologies and the role of the NII in economic and business development; consumer services such as entertainment, video on demand, and interactive multimedia; and, public service applications such as distance education and telemedicine. The underlying assumption of these dialogues is that bandwidth via optical fiber cable, direct broadcast terrestrial and satellite services, and any other emerging and appropriate technology, will be available to carry the market and application requirements inexpensively.

The discussions within the developed nations are parallel to discussions at the regional and international forums focused on the interconnection of the country NII networks to form a "Global Information Infrastructure." Meetings of the G7, Asia-Pacific Economic Cooperation (APEC), Asia-Pacific Telecommunity (APT), and other regional and international organizations have had many discussions on the development of a GII. These regional and international organizations are addressing the many issues of international cooperation, development communications, trade liberalization, and standards.

The continuous revolutionary developments in technology, coupled with the deregulation of telecommunications within nations, trade liberalization of telecommunications among nations, and the dialogues over national and global information infrastructures have encouraged some Pacific Islands observers to suggest a possible "leap-frog" in the telecommunications and information infrastructure by the Pacific Islands Region, even to a point beyond the developing countries of the Pacific Rim.(1) While it is hopeful that a leap-frog will occur, there are many policy, market, and other barriers that will have to be overcome to allow such a desirable progression into the future.

The purpose of this paper is to explore the telecommunications and information infrastructures of the microstates of the Pacific Region and the implications for the ability of these countries to participate in the emerging Global Information Infrastructure. Specifically, this paper explores whether the recent telecommunications developments will result in a "Pacific leap-frog" into the GII or whether narrowband networks and services will continue to be the dominant but "backroad" GII interconnection for the Pacific Region. The paper reviews developments in the Pacific Region in relationship to world wide trends, discusses barriers to development of an information infrastructure, identifies public service telecommunications as an area for priority development and suggests an agenda for policy makers in the Pacific Islands Region.

3. THE PACIFIC ISLANDS REGION

A brief review of the Pacific Region is appropriate since it is sometimes difficult to comprehend the extent of the vast distances, small island land masses and populations, and huge differences between the smallest and the largest countries of the region.(2)

The Pacific Region as shown in Figure 1 consists of thousands of islands scattered throughout the Pacific. The vast physical distances among these countries is best illustrated by looking at the water area of the region about 54 million square kilometers or 21 million square miles of ocean. The Pacific Ocean covers one third of the world and the small land masses of the Pacific Islands together with their Exclusive Economic Zones (EEZ's) of surrounding ocean are larger than the land masses of the continental United States and Latin America combined.

Table 1 shows at a glance, the population, land area, sea area, and political status of the Pacific microstates. The table shows the relative small populations and vast sea areas in the region. Papua New Guinea (PNG), Fiji and the Solomon Islands are the most populous countries of the region and have over 80% of the region's population.

Table 1 also shows the great differences between Pacific countries. Papua New Guinea, for example, has a land mass of 462 thousand square kilometers and a population of 4.2 million people compared with Niue with 259 square kilometers and a population of 2,500. The countries, in general, are not well endowed with natural resources and are very dependent on foreign aid. Some exceptions are Papua New Guinea, because it has diverse and rich resources, and Nauru because it has low population and very high per capita incomes due to its rock phosphate resource. The economies of most Pacific Countries are based on subsistence agriculture and fishing with pockets of export potential in mining, deep sea fishing, tourism, small scale manufacturing, and some specialized agricultural products. Many of the smaller countries are without any natural resources except the ocean surrounding them.

Nearly all Pacific countries are dependent on foreign aid, which on a per capita basis across the region, is the highest in the world. Dependence on foreign aid is itself an issue both for donors as well as for recipient countries. There are large differences in the relative abilities of Pacific countries to absorb this aid effectively and growing signs of aid fatigue are evident among donors. It is clear that not many Pacific countries will be able to continue even their current low growth rates should the donor countries continue to retreat from the region.

It is useful therefore to differentiate the Pacific countries according to their relative ability to build a potentially viable economy at current or reduced levels of aid. One key indicator in this regard is their ability to develop their telecommunications infrastructure and integrate it with the GII.

4. DOMESTIC AND INTERNATIONAL TELECOMMUNICATIONS IN THE PACIFIC REGION

The domestic and international telecommunications infrastructures of the Pacific countries have improved dramatically over the past 20 years, although a few countries continue to lag behind in their domestic communications particularly as measured in telephone lines per 100 of population.

4.1 DOMESTIC TELECOMMUNICATIONS

The progress in the development of the telecommunications infrastructure in the Pacific Islands Region has been a priority, during the past two decades, for governments and regional institutions, such as the South Pacific Forum Secretariat. Before the prioritization, the general telecommunications environment of the Pacific Region can only be described as primitive. There were very few switches and telephones and most interisland links were by HF radio, often of World War II vintage. Satellites were not used for domestic communications because Intelsat, the dominant satellite operator, at that time, provided only for international services. Today, a survey would reveal a dramatic improvement in both domestic and international telecommunications and the information infrastructure as a whole.

Table 2 shows the service level deployment of lines for telephony service and government ownership. The table also shows that several of the Pacific countries have a significant number of main lines per 100 of population and nearly all of the countries have established digital switches in their main urban centers. Table 2 also shows that the ownership of the telecommunications infrastructure generally remains in the hands of government or government corporations. The Commonwealth of the Northern Mariana Islands (CNMI) and the Republic of the Marshall Islands (RMI) are notable exceptions. Telephone companies in the CNMI are completely privately owned and in the RMI the National Telecommunications Authority is also a private corporation with 30% of the shares owned by government.

4.2 INTERNATIONAL TELECOMMUNICATIONS

International telecommunications in the Pacific Region have also improved dramatically during the past 20 years. The Pacific countries almost without exception have replaced old HF radio serving international routes with satellite services, most of which have already been converted to digital carrier technology. Submarine cable systems which provide international connectivity to some island countries are mostly the incidental landings

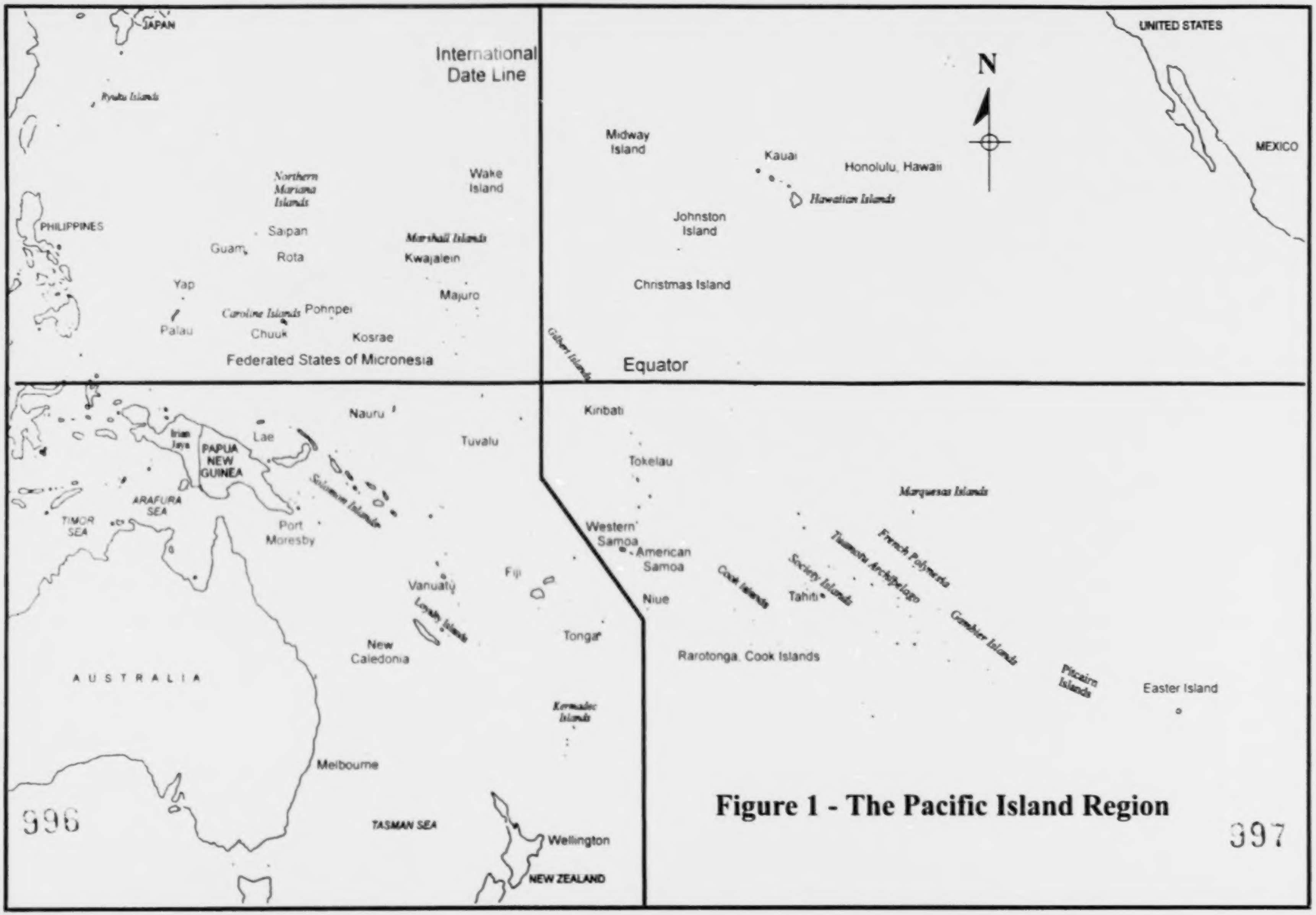
JAPAN
International Date Line
Ryuku Islands
Northern Mariana Islands
Wake Island
PHILIPPINES
Saipan
Guam
Rota
Marshall Islands
Kwajalein
Yap
Majuro
Palau
Caroline Islands
Pohnpei
Chuuk
Kosrae
Federated States of Micronesia
UNITED STATES
N
Midway Island
Kauai
Honolulu, Hawaii
MEXICO
Hawaiian Islands
Johnston Island
Christmas Island
Gilbert Islands
Equator
Nauru
Kiribati
Irian Jaya
PAPUA NEW GUINEA
Lae
Tuvalu
Tokelau
Solomon Islands
ARAFURA SEA
TIMOR SEA
Port Moresby
Marquesas Islands
Western Samoa
American Samoa
French Polynesia
Tuamotu Archipelago
Society Islands
Cook Islands
Fiji
Vanuatu
Niue
Tahiti
Loyalty Islands
Gambier Islands
New Caledonia
Tonga
Rarotonga, Cook Islands
AUSTRALIA
Pitcairn Islands
Easter Island
Kermadec Islands
Melbourne
TASMAN SEA
Wellington
NEW ZEALAND

Figure 1 - The Pacific Island Region

Table 1: The Pacific at a Glance

Country	Population	Land Area	Sea Area	Political Status	Capital	Per Capita GDP	Currency
North Pacific		(sq. miles/ sq. kilometers)	(sq. miles/ sq. kilo-meters)				
American Samoa	52,860 (1993)	84/ 201	390,000/ 1,010,100	Unorganized U.S. Territory	Pago Pago	$3,039	U.S. $
Commonwealth of the Northern Mariana Islands	43,345 (1990)	179/ 478	1,823,000/ 4,721,570	U.S. Common-wealth	Saipan	$9,1770	U.S. $
Federated States of Micronesia	120,000	271/ 701	2,978,000/ 7,713,020	U.S. Freely Associated State (FAS)	Palikir	$1,464	U.S. $
Guam	133,152 (1990)	210/ 541	218,000/ 564,620	Organized U.S. Territory	Agana	$10,152	U.S. $
Marshall Islands	54,000	70/ 181	2,131,000/ 5,519,290	U.S. FAS	Majuro	$1,539	U.S. $
Palau	15,122 (1990)	188/ 488	629,000/ 1,629,110	U.S. FAS	Koror	$1,845	U.S. $
South Pacific							
Cook Islands	17,185 (1986)	93/ 240	1,830,000/ 4,739,700	NZ	Avarua	$3,000	NZ $
Fiji	764,000	7,056/ 18,272	1,290,000/ 3,341,100	Independent Country	Suva	$1,935	F$
Kiribati	78,000	313/ 810	3,550,000/ 9,194,500	Independent Country	Bairiki	$525	A $
Nauru	10,000	8.2/ 21	320,000/ 828,800	Independent Country	Yaren	$10,000	A $
Niue	2,500 (1987)	100/ 259	390,000/ 1,010,100	NZ	Alofi	$1,000	NZ $
Papua New Guinea	4,197,000	178,704/ 462,243	3,120,000/ 8,080,800	Independent Country	Port Moresby	$990	Kina
Solomon Islands	386,000	10,954/ 27,556	27,556/ 71,370	Independent Country	Honiara	$590	SI $
Tonga	105,000	301/ 691	700,000/ 1,813,000	Independent Country	Nuku'alofa	$2,000	pa'anga
Tuvalu	10,000	9.4/ 25	900,000/ 2,331,000	Independent Country	Funafuti	$700	A $
Vanuatu	170,000	4,707/ 12,189	680,000/ 1,761,200	Independent Country	Vila	$1,170	Vatu
Western Samoa	204,000	1,093/ 2,842	120,000/ 310,800	Independent Country	Apia	$865	Tala
French Pacific							
Tahiti	195,000 (1991)	1,544/ 3,543	5,030,000 sq.km	France	Papeete, Tahiti		CFP
Pitcairn Islands	58 (1990)	1.7/47	800,000 sq. km.	Britain	Adamstown		NZ$
Others							
Easter Island (Chile)	2,095 (1989)	63/ 166		Chile	Hanga Roa		Peso
HAWAII	1,108,229 (1990)	6,423/ 16,637	1050/ 2,730,000	US State	Honolulu	$22,450	US$

Source: The basic structure and reference for this table is from David Stanley (1992). The population data was taken from the 1995 World Almanac. Per-capita GDP is taken from the ITU STARS database. Hawaii Data from State of Hawaii Data Book (1994).

Table 2: Telephone Service Providers and Penetration of Phone Services

Economy	Nature of Service Provider	Government v. Private Operation	Total Lines	Total Population	Total Lines Per 100	Main Center
North Pacific						
American Samoa	Government	100%-0%	6,000	52,860	15.38	
Commonwealth of the Northern Mariana Islands	Private	0%-100%		43,345		
Federated States of Micronesia	Corporatized	100%-0%	6,000 (1993)	120,000	(93) 5.00	4.9
Guam	Corporatized	100%-0%	49,000	133,152	.37	
Marshall Islands	Private	25%-75%	1,193	54,000	('93) 5.00	7.4
Palau	Corporatized			15,122		
South Pacific						
Cook Islands	Government	60%-40%	3,500	18,552	('93) 19.44	13.4
Fiji	Government	100%-0%	68,532	764,000	('93) 1.90	
Kiribati	Government	100%-0%	1,130	78,000	13.00	
Nauru	Government	100%-0%	1,600	10,000	20.80	
Niue	Government	100%-0%	390	2,267	(93) 0.90	9.3
Papua New Guinea	Government	100%-0%	73,068	4,197,000	1.45	9.8
Solomon Islands	Corporatized	60%-40%	5,976	386,000	('91) 5.40	8.6
Tonga	Government	100%-0%	3,984	105,000	1.3	
Tuvalu	Government	100%-0%	150	10,000	('93) c 2.40	c. 14
Vanuatu	Corporatized	34%-66%	6,480	170,000	('91) c 2.50	
Western Samoa	Government	100%-0%	4,335	204,000	2.10	c. 9.8
HAWAII (1993)	Private	0%-100%	649,268	1,108,229		
United States	Regulated industry	0%-100%	96,364,200	260,713,585		

Sources: Cutler & Associates (1994), State of Hawaii Data Book (1994), ITU World Development Report (1994), annual reports of telecommunication organizations, and other sources.

of intercontinental cables installed to carry trans-Pacific traffic. These links traditionally have provided excellent service to a few fortunate Pacific countries but their numbers are shrinking as new technology cables span greater distances, minimizing landings for shore based service facilities.

Table 3 shows the submarine cables that have been deployed or planned. Many more are in the North rather than in the South Pacific. Figure 2 shows the submarine cable network in the Asia-Pacific Region in the 1980's and Figure 3 shows the optical fiber submarine cables that are planned or in service. Together, these figures show that the only countries in the region that are served by submarine cables are Guam, Fiji and Papua New Guinea. The CNMI is expected to have fiber connectivity in 1996 that will link Saipan, Tinian, and Rota to Guam.(3) Palau is in the process of investigating the possibility of a fiber connection.

An interesting situation that will come about with the further installation of submarine fiber cables is the retirement of copper cables. As this process proceeds, there will likely be a reduction of countries that will have cable access. Fiji and PNG, for example, may be in danger of losing their cable feeds since it is no longer necessary to land the new technology cables as often for power feeding and maintenance access. The economic cost of landing the fiber cables has not been justified by the small communications markets in these Island Countries.

Satellite communications have been, and will continue to be for the foreseeable future, the principal international telecommunications infrastructure of the Pacific Region.(4) Intelsat is the almost exclusive satellite carrier of public telecommunications in the Pacific and has full Pacific coverage through its global and hemispheric satellite footprints. Although there are many commercial satellites with footprints covering parts of the Pacific these new satellites are not being used by Island Countries for their public telecommunications networks, and little if at all for other services. None of the high power spot beams on any of these satellites is primarily focused on the Pacific Region for obvious market reasons.

The new satellite technologies likely to impact soon on the Pacific are the Low Earth Orbit (LEO) systems. However, it appears likely that these systems will not be designed for broadband applications. As such, they will not be able to replace the missing high power spot beams from the geostationary satellites and so will not be capable of providing Pacific connectivity with the broadband information highways in the developed world.

Of more concern, therefore, is the narrowband service which LEO's will deliver in the Pacific. Those LEO systems with large footprints and gateway earth stations which are too expensive to deploy in the Pacific Countries and will be biased towards providing only international services, unless the LEO itself can provide the links on both sides of the gateway for a domestic connection. The alternative is for the LEO operator to negotiate a very inexpensive backhaul via conventional satellite or cable facilities and that does not look a likely proposition given the small traffic volumes involved.

Those LEO systems which have footprints too small to cover the distance between Pacific Islands and Pacific littoral countries will not be able to provide any service at all unless their gateway stations are affordable in the Pacific Countries. It is too early yet to be sure what the outcomes will be and exactly what sort of narrowband services the LEO's will be able to provide in the Pacific.

5. INTERNET IN THE PACIFIC AND THE GII

For many Pacific countries "Internet," next to basic telephone service, is one of the most important telecommunications services to government, education, and other nonprofit institutions. Access to information, electronic mail, and the ability to transfer computer files are important to many government and educational institutions, and especially regional organizations that have a need to communicate with other organizations around the world.

With over 70 million users and almost every organization of size connected in some way in the developed and emerging economies, Internet is viewed as one of the most important communications tools to help overcome some of the severe information barriers to development which impact on Pacific countries.(5)

The traditional transport of written and printed information is through the postal service. In the Pacific, the postal service can take anywhere from three days by special delivery, one to two weeks normally, and perhaps up to two months given the remoteness of some destinations in the Pacific. Thus, it is no surprise that Internet, and more specifically electronic mail, is viewed by the developing microstates of the Pacific Region as a means to reduce disparities in access to needed resources.

Ultimately, Internet is poised to become a means to improve education, enhance health and welfare services, facilitate economic development, and to enable participation of Pacific people in the GII. The growth of Internet and the information and services that are available through the Internet, suggest that it could become the most important single factor in reducing the "information

Table 3: Past, Present, and "Talked About" Submarine Cables in the Pacific

Name	Route and Countries	Data Operational and Notes
Aloha (Talked about) Transnational Telecom Ltd	Northwest Hawaii	Unknown
AZCAN (Australia, New Zealand, Canada) Owned by OTC, Telecom Corp, Teleglobe, U.S. Carriers	Canada - Port Alberni Hawaii - Keawaula Fiji - Suva New Zealand - Auckland Australia - Norfolk Island Australia - Sydney	1984 Coaxial cable with 1,380 circuits from Australia to Canada and 480 circuits from New Zealand to Australia.
APNG OTC, PNG	Papua New Guinea - Australia - Cairns	1976 480 circuits.
GPT AT&T, others	Guam Taiwan Philippines	1989 Optical fiber - 280 Mbps/18,900 circuits
HAW-4 (East)	Hawaii - Makaha California -	1989 180 Mbps
Pacific Transit Cable (Talked About)	Chile - South Pacific Island - Fiji -New Zealand	Unknown
PACRIM (East) Owned by AT&T, KDD, OTC, Telecom Corp.	Hawaii - Makaha New Zealand - Urenal	1993 560 Mbps/37,000 circuits.
PACRIM (West) Owned by AT&T, KDD, OTC, Telecom Corp.	Guam - Agana Australia - Sydney	1996 560 Mbps/37,000 circuits
Seacom 1	Singapore Hong Kong Guam	1965 82 circuits
Seacom 2 OTC, Telecom Corp., C&W, others	Australia - Cairns PNG Guam	1967 166 circuits
Transpac 1 (TPC 1) KDD, OTC, AT&T, HTC, PLDT	Japan - Guam - Philippines Guam -Wake - Midway -Hawaii	1964 128 circuits (Retired)
TPC 2 KDD, OTC, AT&T, HTC	Japan- Guam Hawaii	1975 845 circuits (Retired)
TPC-3 KDD, AT&T, others	Hawaii - Keawaula Guam - Agana	1989 180 Mbps
Tasman-1 OTC, Telcom Corp.	Australia - Sydney New Zealand - Urenul	1976 480 circuits
Tasman-2	Australia - Sydney New Zealand - Urenul	1991 1,680 Mbps/113,400 circuits

Source: Wetzel (1989:179-183), Dean (1995:66-68).

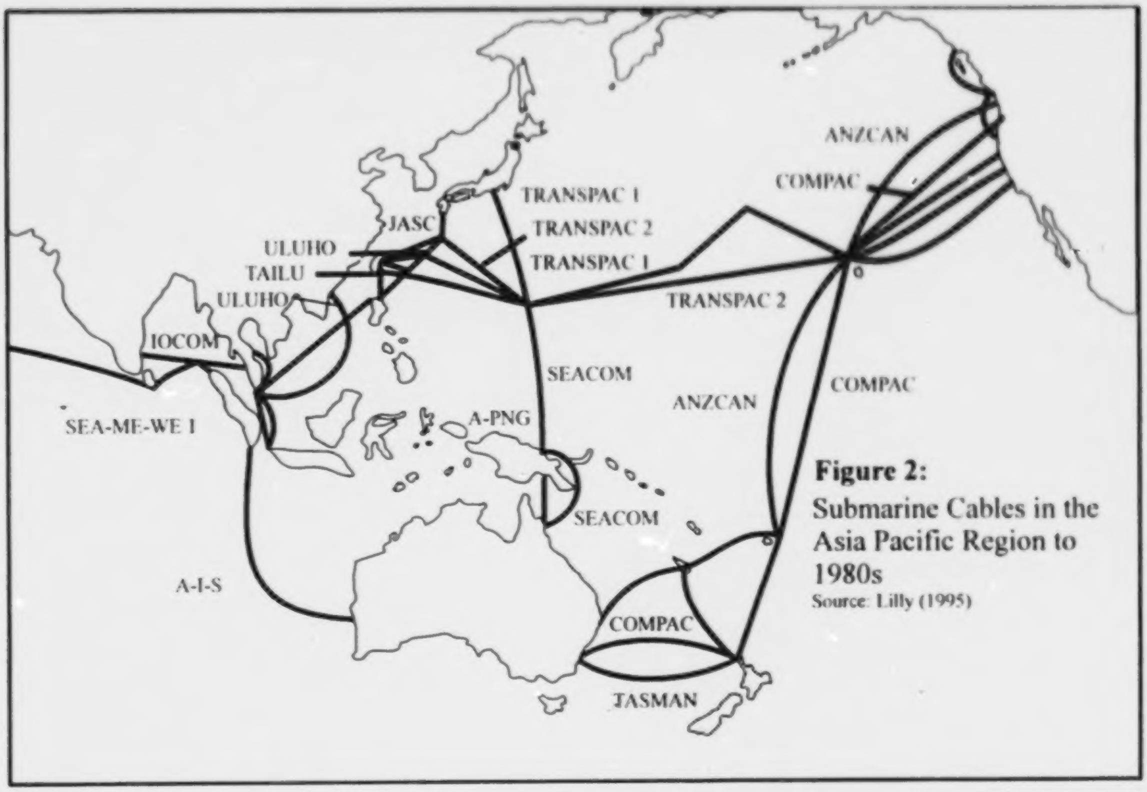
ANZCAN
COMPAC
TRANSPAC 1
TRANSPAC 2
TRANSPAC 1
JASC
ULUHO
TAILU
ULUHO
TRANSPAC 2
IOCOM
SEACOM
COMPAC
ANZCAN
SEA-ME-WE 1
A-PNG
SEACOM
A-I-S
COMPAC
TASMAN

Figure 2:
Submarine Cables in the Asia Pacific Region to 1980s
Source: Lilly (1995)

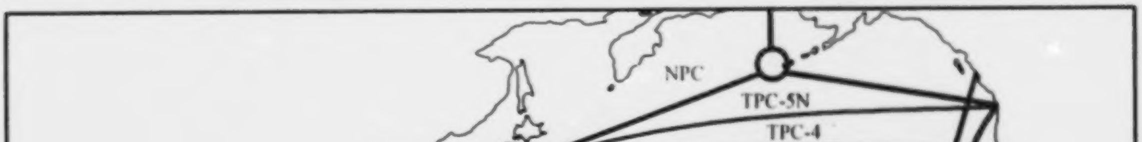
NPC
TPC-5N
TPC-4
CANPAC
HAW-4
TPC-3
TPC-5N
APC
FLAG
PacRim West
PacRim East
PTC

Figure 3:
Fiber Optic Cables in the Asia Pacific Region: Current and Possibles
Source: Lilly (1995)

gap" between the developed world and the developing countries of the Pacific.

There are several reasons why the use of Internet, especially its interactive services, has been limited in the Pacific Region. First, there is a general lack of understanding of its potential. Most of the potential users of Internet in the Pacific have yet to experience "surfing the net" or even the exchanging of electronic mail. This lack of understanding and experience makes it difficult for both users and policy makers to be able to understand the benefits and value of Internet.

Second, the cost of dial-up telecommunications are high and there are no policy frameworks, programs, or other subsidies which lessen the very high cost of connecting to the Internet through a voice circuit via Australia or New Zealand to the West or the USA to the East. The international telephone per-minute rates for calls in the Pacific countries are considerably higher than they are developed countries. The rates may vary from 75 cents per minute to $3.00 per minute, depending on the time of day and day of week the call is made. The cost of "dial-up" calls simply puts this method out of reach for the Pacific market, even for batch mail transfers through "UUCP" type connections.

The cost of leased services is also very high. For example, as reported by Okamura, Blake, Lam and Mukaida (1995:811), "the University of the South Pacific (USP) at the Suva, Fiji campus is currently paying $90,000 Fijian annually (about $60,000 US Dollars) for a 4.8 Kbps link from Fiji to Australia."(6) The dedicated circuit is used solely for USP access to Internet. This bandwidth will not support Internet applications beyond electronic mail and other text services for its user population but it is far better than not having any Internet services. The high cost of leased services also inhibits Internet access from the extension centers of USP.(7)

To address both of these barriers to access, the Forum Secretariat Telecommunications Division proposed a "value-trial" of Internet in the Pacific Region. The trial began service in Fiji in December 1995. The purpose of the trial is to provide a subsidized Internet service for as many participants as possible from Fiji and other Pacific countries to test the market and to generate a core of knowledgeable Internet users. The ability to provide a trial subsidy for a limited time period was made possible by provision of international transmission from Telecom New Zealand and Fiji International Telecommunications Ltd. By this means, it is hoped that entrepreneurs in the Pacific will also develop their knowledge and use of the network to export Pacific information to the world as well as to import information and E-mail from the world for use in the Pacific.

Access to Internet and electronic mail is better in parts of the North Pacific. There are several Internet and electronic mail service providers in Guam, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, and American Samoa. However, the cost of the services is still beyond the financial means of many public service institutions and the general population.

Today, Guam has the most developed Internet environment both for the public as well as the private sector. There are several options for electronic mail access through the competitive international carriers and small companies. The University of Guam also has a 64 Kbps link to the University of Hawaii used for educational purposes. The Guam link costs about $48,000 per year.(8) There are also other Internet providers for the private sector. In the FSM, CompuServe and other services are available through an economy packet network service.

6. "PUBLIC SERVICE" NETWORKS IN THE PACIFIC

At the same time as there is a growing awareness of the importance and usefulness of an information infrastructure in the Pacific Region there is also a renewed interest in "public service" networks, some of which have been around for many years. "Public Service" telecommunications have been defined broadly by Okamura and Mukaida (1995:14) as "the use of telecommunications and information technologies by government, educational, and nonprofit organizations for education, medical and health services, emergency management, environment and resource management, and economic development."

In most developed countries the use of telecommunications and information technologies for public services are well-developed and accepted concepts. Public radio, public television, and rural distance education and telemedicine programs are a few examples of subsidized programs in developed countries. In many developing countries, however, the concept has not been fully developed or even explored in depth. Further, in the past, the concept of public service telecommunications has been mostly regarded with suspicion if not hostility by established monopoly Telco's, but attitudes are changing and there is good cause for optimism for the future of these services.

The increasing awareness of the potential of "Public Service" telecommunications operators in the Pacific Islands region may be attributed to four major sources. First, regional organizations, especially in the South Pacific, have been aggressively promoting a telecommunications and information infrastructure for their own organizational purposes. Regional organizations must maintain communication with their constituencies and a good telecommunications infrastructure is essential.

Second, regional organizations led by the Forum Secretariat have been directing attention to the regulatory issues and on opportunities for organizations, both mainstream telecommunication carriers and those on the fringes, to contribute to improved service delivery and affordability of both basic and value-added services.

Third, programs such as the Telecommunication and Information Infrastructure Assistance Program of the United States have generated considerable interest by government and educational institutions in the information infrastructure.

Finally, experimental programs such as the Pan Pacific Education and Communication Experiments by Satellite (PEACESAT) and Pan Pacific Regional Telecommunications Network Experiment and Research by Satellite (PARTNERS) have provided a stimulus to advance concepts of public service telecommunications. The fact that PEACESAT, which already provides basic access to Internet for some government, education, and non-governmental users throughout the Pacific, is being upgraded to increase its digital capacity, connectivity and service in the Pacific Islands Region has caused great interest.(9)

There are several existing satellites that provide limited services for "Public Service" network operators without charging for the space segment in both the North and South Pacific. These satellite systems have very limited capacity and are primarily designed for other purposes. PEACESAT, for example, uses a satellite that was originally designed and launched for weather data gathering purposes.(10) The Japan "PARTNERS" network, which is used for distance education and telemedicine experiments in Fiji, PNG, and Hawaii, uses the ETS-V satellite which was originally developed for mobile satellite communication experiments.(10) Intelsat also has a SHARE program that enables microstates to use excess bandwidth on a preemptive basis.(11) Parts of the University of the South Pacific Network used the Intelsat SHARE links for a period of time.(12)

7. BARRIERS TO A PACIFIC INFORMATION INFRASTRUCTURE

There still remains a considerable gap in both basic and advanced services despite the fundamental improvements in the telecommunications and information infrastructure of countries in the Pacific Region. Cutler and Associates (1994) suggests that the gap in basic telephony services will take many years, perhaps decades, to overcome if capital investment remains at present levels. This indicates that, at best, the existing gap between Pacific countries and their neighbors of the Pacific Rim will stay much as it is at present for basic telephony services, neither reducing nor increasing. The gap for value-added services and the information services of the future is likely to widen because of the inability of Pacific countries to gain access to the benefits of optical fiber and V-SAT technologies which provide inexpensive digital bandwidth.

In many advanced countries attention is being given to extending the present definition of basic service on which notions of community service obligations of telephone companies are both based and costed. The basic service of the future is likely to be able to deliver a range of simple information, facsimile, banking, and other services made possible by digital technology, on top of the basic voice service. The conventional view is that there is little chance of such a redefinition of basic service in the Pacific Region until the plain old telephone service is available to everyone.

This view, however, is in stark contrast to at least one Pacific observer who suggests that "all is not as bleak as it sounds." Ogden (1995:593), for example, acknowledges that "[a]ccording to conventional wisdom, ... [it] appears that the Pacific Islands states and territories are much too small, too poorly endowed with resources, and too isolated from the centers of economic growth for their inhabitants ever to rise above their present condition of dependence on the largess of the wealthier metropolitan nations." However, Ogden argues that "[a]s pernicious as this view has been in past as well as present development planning in the Pacific Islands, all is not as bleak as it sounds. In a perverse way, many of the Pacific island nations are fortunate that they have lagged so far behind the curve when it comes to telecommunication technologies. Rapid technological advances in digital telecommunications coupled with declining costs mean that latecomers can 'leap-frog' to a level of services not much different from those that even the relatively rich Rim countries could only have dreamed of five years ago."

This optimistic view must be evaluated in relationship to the realities of the Pacific Islands region. There are several important barriers that contribute to the continuation of the availability gap in both basic and value-added services. First, the geography, low population and absence of an abundance of natural resources in the Pacific countries will continue to be a barrier to the development of telecommunications and information infrastructures in the region. In essence, this barrier translates as insufficient capital investment to service profitable opportunities and to cross-subsidize unprofitable but socially desirable services.

Second, and understandably, there are conflicting views of the value of such an infrastructure. There is always a real question as to whether scarce budget resources should be spent on books or computers. Although we are not addressing such issues here, it is important that they be at least acknowledged. Further, there are always questions about the impact of new communications technologies on Pacific cultures and whether the imposition of these developments are in the interests of the Pacific peoples or those of external countries and companies. These conflicting views are not often documented but are ever present in discussions of the Pacific Islands Region.

Third, there is a lack of trained personnel to support the development of an information infrastructure within many of the Pacific countries. This problem cannot be resolved through a one-time training program, but requires a continuous effort in human resources development.

Fourth, there is no contemporary policy framework to support the development of a national information infrastructure in many of the Pacific countries. The institutional and regulatory disability in most countries derives from their colonial legacy of legislation and regulation which was framed many years ago and which in most cases remains in place today. In some countries, even the advent of corporatized or partially privatized telecommunications service providers has not significantly altered this situation. Even in those countries which have established a framework of policy and legislation commensurate with contemporary structures of the service providers, these new frameworks are often too rigid to allow evolutionary changes at the speed which is desirable given the market place changes happening now. Some of the exclusive joint venture franchise agreements negotiated in the relatively recent past are seen now as too inflexible to be always in the best national interest.

At the same time, Ogden may be correct in postulating that Pacific countries will be able to participate fully in the enhanced capability of the basic telephone service, or at least those people who have a telephone and can afford the costs will do so.

Most Pacific countries have converted their international links and their main switches from analogue to digital technology. This creates the technical possibility for enhanced services. However, it is a much more risky proposition to forecast when basic services will be available to everyone in the Pacific region and just as difficult to predict when digital services will be delivered to customers premises. There are few indications that the digital revolution can extend to Pacific countries as rapidly as it has in the developed world.

8. PACIFIC INFORMATION INFRASTRUCTURE - AN AGENDA FOR POLICY MAKERS

In summary, any discussion of an NII or GII based on high-capacity networks for the Pacific Region is simply irrelevant today. The microstates of the Pacific Region, with the exception of Guam, the Commonwealth of the Northern Mariana Islands, and perhaps Palau, will not be connected via fiber to the international grid in the foreseeable future. Further, even though there are many satellites that have footprints over the Pacific, there is presently little indication that these footprints will put high satellite power (EIRP) onto Pacific countries to facilitate the inexpensive V-SAT services and private broadband networks that are available in the Northern Hemisphere. This chronic lack of inexpensive bandwidth in almost all countries will mean that the dominant mode of connections from the Pacific into the GII will continue to be based on narrowband links, at least for the foreseeable future.

This will lead to the development of a Pacific Information Infrastructure which is far different than those of developed countries and different even from developing countries of East and Southeast Asia. For the Pacific Islands Region, the need is for more telephones, more basic data communications, basic access to electronic mail and file transfer services, and better radio and television services. The GII for the Pacific means the effective interconnection of these services with the rest of the world, and in particularly, it means access to electronic mail and the Internet, and the creative applications of narrowband technologies in high potential areas such as trade and economic development, education, and health and medical services.

At the same time, the development of the narrowband Pacific infrastructure is no less important for the prosperity of Pacific countries than the development of a broadband infrastructure is in other parts of the world. Ac-cordingly, the development of a domestic information infrastructure and its connections to the emerging global information infrastructure should become, once more, a priority area of interest for policy makers in the Pacific Region, as was the development of the telephone network in the 1980's. A revitalization of interest in the information infrastructure is a precondition to ensure that the "telecommunications gap" does not widen further, especially for value-added and information services.

The recognition of such priorities should ideally lead to discussions among stakeholders - government and education policy makers, users, carriers, public service carriers, and others (e.g. regional organizations and non-governmental organizations) to develop appropriate regional strategies, programs, and regulatory changes designed to benefit both national and regional interests.

Many difficult issues will need to be addressed in order to build on the successes of the past to secure the benefits of the revolution in telecommunications and information technology. Some of these issues include the redefining of roles and relationships among users, ministries and carriers, the optimizing of the role of the "Public Service" telecommunications networks, the development of appropriate reinvestment strategies for telecommunications carriers, and the pricing and cross subsidies for value-added services. "Public Service" networks promoted by the University of Hawaii and innovative experiments by the South Pacific Forum Secretariat are offered as examples of how a Pacific Information Infrastructure is being actively promoted. These activities should be seen as complementary and vital to the participation of Pacific microstates in the future information economy, and not competitive with the mainstream operators.

Although in the past most Pacific countries have been preoccupied with national rather than regional issues there have been a few outstanding, successful regional initiatives. The PACT DAMA network promoted by the Forum Secretariat and largely financed by Australia is one of these, and the PEACESAT network, initiated by the University of Hawaii and funded with U.S. assistance, is another.

The long term availability of space segment capacity for "Public Service" network providers is another very important concern for policy makers and for Pacific Countries. Up to now, the National Telecommunications and Information Agency (NTIA) of the U.S. Department of Commerce has been almost alone in leading the discussion on the future possibilities for the continuing availability of this very valuable resource. Today, it may be timely for a regional interest group of NGO's, regional organizations, Island Counties and principal donors of aid programs in the Pacific to collaborate on this very important question.

9. CONCLUSIONS

There is no indication that technology will become available in the foreseeable future which will enable people and countries of the Pacific Region to afford to participate in the broadband information infrastructure which is rapidly evolving in the Northern Hemisphere and Asia. Unit costs and prices in the sparsely populated Pacific may never be as low as they will be in the developed world. At the same time, the real needs of Pacific people can be met, and a very effective interconnection with the global information infrastructure can be developed using narrowband technology, provided that the application of this technology is sufficient to cover the entire region.

Low earth orbit satellite technology will obviously present some opportunities for the Pacific but, like nearly all communications technologies designed for application in other parts of the world, some adaptation either technically or organizationally is likely to be required if an optimum application is to be achieved for island countries. Likewise with existing, and other emerging technologies it is likely that the policy, organizational, and regulatory issues will be more important than the technology itself in determining the information future of the Pacific Region.

There are some indications that these policy, organizational, and regulatory issues are being addressed by countries and regional organizations. For example, in the South Pacific, the Forum Secretariat has been closely involved in technical training and technology planning issues of telecommunications for the last two decades. Now the focus of the Forum Secretariat has shifted to the institutional and regulatory issues and promotion of value-added and information services to complement basic voice services. It has also shifted to a concern for the consumers of telecommunications that are not being served by traditional service providers.

Women, community organizations and grass roots providers of education, health and welfare services are high on the list of consumers of telecommunications that are not being well-served. This reality must be viewed against the background of falling aid to the traditional telecommunications sector. The implication is that aid in the future for telecommunications is likely to target telecommunications consumers rather than traditional service providers. NGO's and regional organizations currently providing such grass roots services are likely to be well placed in the contest for what aid funds continue to flow in the telecommunications sector as we approach the end of the 1990's.

In the North Pacific, there are also indications that these issues are being addressed. The Association of Pacific Island Legislatures, for example, has established a committee that is attempting to address telecommunication issues and to develop a regional program effort in the area of telecommunications. The Pacific Basin Development Council (regional organization), the Pacific Caucus of Emergency Managers (Users), the U.S. Department of Interior, the U.S. Federal Emergency

Management Agency, and PEACESAT have collaborated to initiate the development of an Emergency Management Network. Guam is seriously studying the possible privatization of its telecommunications corporation.

The resilience and creativity of the regional organizations and the persistence by which government policy makers, administrative ministries, and users seek to address these issues will be very important factors in the future of Pacific telecommunications and the development of an appropriate Information Infrastructure for the Pacific.

* * * * *

ENDNOTES

- The opinions and the interpretations in this paper are those of the authors and do not necessarily represent, nor do they purport to represent, the views, opinions, or the work programs of the South Pacific Forum Secretariat or the Social Science Research Institute of the University of Hawaii.

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1. The idea of a "leap-frog" is ever-present in papers discussing telecommunications in the Pacific Islands region. In 1983, for example, Karunaratne (1983: 93) suggests that "[t]he Pacific Islands Nations face the prospect of leap-frogging into an information era from a subsistence economy." Twelve years later, the same sentiment is echoed by Ogden (1995). These views emphasize the promise of telecommunications and information technology, but, unfortunately, tend to ignore important policy, political, cultural, and economic (market) barriers that would enable the leap-frog to occur.

2. There are very large differences among the Pacific Island microstates in culture, geography, political organization, extent of urbanization, and so on. These differences cannot be explored in this paper, but need to be acknowledged at the start.

3. "Tenorio signs lease for fiber optic cable." Marianas Variety News and Views, November 11, 1995. The article reported that the cost of telephone calls between CNMI and the continental U.S. will be $.55 per minute. The article cited the current costs for voice telephony at $1.85 for the 1st minute and $1.75 for each subsequent minute.

4. See Cooperman (1995) for a useful discussion of satellites in the region.

5. No one really knows how many computers are attached to the Internet. However, the latest estimate reported by Dr. Haruhisa Ishida, President of the Internet Society, at a meeting of the Asia-Pacific Telecommunity held in Tokyo, Japan (October 17, 1995), is 70 million.

6. The same information on the cost of Internet was reported by John Clayton, Manager of the Computer Center at the University of the South Pacific, at the 11th World Communications Forum in Shibuya, Japan, October 2627, 1995. His estimate was that USP pays U.S. $50,000 for the 4.8 Kbps link to the Australia Research and Education Network through TELSTRA.

7. In the South Pacific the USP operates Extension Centers in 12 other countries. Due to the cost of leased line telecommunications in the region, none of these centers except for Fiji can access Internet on a 24-hour, 7 day-a-week basis.

   The high cost and low service of this access led the USP to hire a consultant to explore the potential of a consortium to purchase additional bandwidth to support both the University and a group of other NGO's. The report of the consultant recommended that a link of 19.2 Kbps be leased to initiate such a group service.

8. The cost of the link was reported by Dr. Hiro Kurashina, Director, Micronesian Area Research Center, the University of Guam, at the Honolulu Meeting on the Guidelines for Distance Education in the Pacific Islands, Sasakawa Peace Foundation, Honolulu, Hawaii, January 26, 1995.

9. See Okamura and Mukaida (1995, September; and 1994) for a discussion of the current and planned directions of PEACESAT.

10. PEACESAT currently uses an obsolete geostationary weather satellite, GOES-2, provided by the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce. The satellite has a very limited bandwidth of 10 MHz and low power. As such, it has a limited capability for support of the Pacific.

11. The Japan PARTNERS Network was established by the Japan Ministry of Posts and Telecommunications in celebration of International Space Year in 1990. The network enables sites in Fiji and PNG to participate in distance education seminars and discussions through the use of the Engineering Test Satellite (ETS-V). The video teleconferences are 64 Kbps.

12. The Intelsat links used by USPNET include Fiji, Tonga, Cook Is, Vanuatu, Solomon Islands, Fiji. HF is used in Western Samoa, Tuvalu, Niue, Nauru.

The Marshalls, Kiribati, Tokelau have no access. Intelsat originally donated the use of these links for a period of time. It is not known how much the links currently cost.

13. The USPNet consists of a single voice circuit used mainly for the administration of the extension program. Tutorials are also supported through the network. USP was a leader in the early 1970s in the use of satellite communications for "distance learning." Today, the extension program is essentially a correspondence program with tutorial support provided by faculty and local tutors. These developments were supported by USP's access via PEACESAT from 19721985.

BIBLIOGRAPHY

Cooperman, W. (1995) "Communications Satellites for the ASIA-Pacific Region: 1995 Status Report," Proceedings of the Pacific Telecommunications Conference '95, 179190.

Cutler and Associates (1994, April) Telecommunications, The Pacific Link: A report to the Pacific Forum on the development of the telecommunications sector in the region. 78.

Cutler and Associates (1994, April) Telecommunications, The Pacific Link: A report to the Pacific Forum on the development of the telecommunications sector in the region, Summary Report. 20.

Cutler, T. (1994, December) "Contemporary Telecommunications Issues in the Pacific," Pacific Telecommunications Review, 38.

Dean, D. (1995) "Fiber optic submarine cable for the Pacific Region," Proceedings of the Pacific Telecommunications Conference '95, 6568.

Karunaratne, N. D. (1983). Telematic infrastructures for the developing Pacific. Proceedings of the Pacific Telecommunications Conference 1983, 9398.

Lilly C.J. and Thornton, G. "Recent economic implications for submarine systems in the ASIA-Pacific Region," Pacific Telecommunications Conference '95, 475480.

Matyas, R. (1993) Study of Educational Telecommunications Requirements for the South Pacific. Prepared by R. Matyas, MPR Teltech Ltd. for the commonwealth of learning, Vancouver, Canada, 96 pgs.

Ogden, M.R. (1995) "Widening the Chasm or Closing the Gap? Converging Information Technologies and Pacific Island Microstates." Proceedings of the Pacific Telecommunications Conference '95, 592599.

Okamura, N. (1995, April) A Primer on Advance Telecommunications and Information Networks in the Pacific Islands Region. Report prepared for the Hawaii Information Network Corporation. 80.

Okamura, N. and L. Mukaida (1995, September) "Public Service Telecommunications: PEACESAT," Pacific Telecommunications Review, 1423.

Okamura, N., A. Blake, R. Lam, and L. Mukaida. (1995, June) "Internet Access via PEACESAT," Proceedings of the INET '95 Conference, 811819.

Okamura, N. and L. Mukaida. (1994) "PEACESAT: A Regional Telecommunications Alliance," Proceedings of the Pacific Telecommunications Conference '94, 811819.

Stanley, D. (1992). Micronesia Handbook: Guide to the Caroline, Gilbert, Mariana, and Marshall Islands. Hong Kong.

Wetzel, H. (1989). New zealand and pacific islands telecommunications equipment markets. Prepared by the U.S. international trade administration of the department of commerce, Washington, D.C. 199 pgs.

Strategies for Working in Collaboration to Support Emergency Management Communications in the North, Central and Western Pacific

Christina Higa*, David N. Kennard**, Jerry B. Norris*** and Marilyn Shigetani****

*Systems and Operations Manager, PEACESAT Headquarters, Honolulu, Hawaii U.S.A
**Hazard Mitigation Specialist, FEMA, Pacific Area Office, Honolulu, Hawaii U.S.A
***Executive Director, Pacific Basin Development Council, Honolulu, Hawaii U.S.A
****American Red Cross Special Representative to FEMA, American National Red Cross, Honolulu, Hawaii U.S.A

1. ABSTRACT

This paper provides an overview of various U.S. organizations involved in disaster planning and relief efforts in the North, Central and Western Pacific. It also describes the nature of environmental threats in the Pacific which illustrates the grave necessity of communication networks to support emergency management efforts. Although there are numerous players involved in operating and maintaining such communication networks, this paper focuses on two specific examples: the Hawaii State Voluntary Organizations Active in Disaster (HSVOAD) and the Emergency Management Network via PEACESAT.

1.0. INTRODUCTION

The importance of disaster planning and communication is often underplayed until a disaster occurs. Information gained from past disasters play an important role in improving the organization of existing and developing infrastructures to better support emergency communication. These networks must be operable in the absence of conventional infrastructures, such as electricity and telephone lines. Redundant networks are relied upon even when conventional infrastructures are in tact because telephone lines are often overloaded by the general public. Accurate and timely information distribution is also critical in times of disaster. In addition to being reliable and viable systems, cost effectiveness is key. Today, collaborative efforts among emergency management organizations, communication network managers and technicians are combining forces to address the emergency communication needs in disaster preparation and response.

2.0. BACKGROUND

The Federal Emergency Management Agency, or FEMA is the governmental agency tasked with coordinating the federal disaster response and recovery process. It also implements the President's Disaster Assistance Program which is designed to supplement the efforts of the state and local government, voluntary agencies and others in providing assistance during emergencies.

The Pacific Islands served by FEMA Region IX Pacific Area Office include the American Flag Pacific Islands which are the State of Hawaii, the Territories of American Samoa and Guam, and the Commonwealth of the Northern Mariana Islands, and the Freely Associated States which are comprised of the Republic of the Marshall Islands, the Federated States of Micronesia (Kosrae, Pohnpei, Chuuk and Yap), and the Republic of Palau.

FEMA Region IX services an enormous Pacific region which extends from 134 degrees east longitude to 155 degrees west longitude and 14 degrees south latitude to 22 degrees north latitude (See Figure A).

The combined Exclusive Economic Zone (EEZ) is about 4.3 million square miles of water. The total land area is 7,562 square miles, less than 0.2 percent of the combined EEZ. Approximately 85 percent of the total land area is in the State of Hawaii. (See Table 1)

Table 1: Pacific Area Data

	EEZ (1000 sq mi)	LAND AREA (sq mi)	LAND/SEA (%)	POP (1000's)	DENSITY (Pop/Area)	DENSITY 2 (Pop/EEZ)
RMI	822	70	0.009	43	614	0.05
FSM	1177	430	0.037	103	240	0.09
Kosrae		68		7	103	
Pohnpei		214		30	140	
Chuuk		73		56	767	
Yap		75		10	133	
Rep. Palau	242	153	0.063	15	98	0.06
Subtotal	2241	653	0.029	161	247	0.07
Am. Samoa	156	77	0.049	47	610	0.3
Guam	77	209	0.271	133	636	1.73
CNMI	164	200	0.122	35	175	0.21
Subtotal	397	486	0.122	215	442	0.54
Hawaii	923	6423	0.696	1108	173	1.2
Misc. Atolls	759	**		**		
Subtotal	1682	6423	0.382	1108	173	0.66
TOTAL	4320	7562	0.175	1484	196	0.34

The region is lightly populated, although specific islands may have a high density (e.g. Majuro with 5,244 persons per square mile). The total population is 1.484 million, and the population density is 196 persons per square mile of land and 0.3 persons per square mile of EEZ. About 75 percent of the population, or 1.1 million, is in the State of Hawaii. (See Table 1).

Several natural hazards are common to the region, including tropical cyclones (called hurricanes in the eastern Pacific, and typhoons in the western and central Pacific), flash floods, flooding due to high waves, tsunamis, earthquakes, volcanic eruptions, drought and storm surge. These can cause enormous damage, some of which are severe enough to warrant assistance from the federal government. Since 1982 there have been 30 federally declared disasters which generated $531 million in total obligations for FEMA assistance. (See Table 2). The total damage of these disasters was in excess of $2.2 billion.

The primary threat in the region is tropical cyclones. Twenty-five of the declared disasters since 1982 and 96 percent of the FEMA obligations were the result of cyclones. The six events causing the most obligations were cyclones (Iniki - $229 million, Val - $77 million, Omar - $63 million, Ofa - $66 million, Owen - $17 million and Nina - $16 million). Four of the cyclones (Roy, Russ, Yuri and Axel) caused substantial damage in multiple jurisdictions.

The severity of these natural hazards have been costly in the resiliency of both the people and economy. This emphasizes the importance of disaster planning and response in the Pacific. Communication is the critical vehicle for the organization and collaboration of relief efforts needed to provide health care, food, water, shelter and the rebuilding of communities.

Damage to inter- and intra- island communication systems is an important effect of the tropical storms. Given their relative isolation and geographic make-up, the communication system within a jurisdiction and with the outside world is vitally important. A cyclone's high wind and rain may cause damage to power and telephone lines, communication satellite dishes and electronic equipment. It is not uncommon for phone communications to be out during and for several days after the storm, hampering the response and recovery function of local, state and federal agencies. The development of a reliable, survivable combination of communication systems for emergency management would be a large step toward solving this repetitive problem in the region. The many players involved in emergency management including policy makers, managers and technicians are working together towards merging resources to build redundancy and organization in emergency management communication.

3.0. EMERGENCY MANAGEMENT ORGANIZATIONS

The role of government and voluntary agencies like the American Red Cross in disaster response and recovery activities can best be described as an integrated collaborative effort. Governments at all levels--local, state and federal share in the responsibility of mitigating against, preparing

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for and responding to disasters and emergencies within their jurisdictions. However, for many years, governments have relied on the expertise and resources of voluntary agencies to augment their efforts in disaster planning and response.

Table 2: Pacific Area Disasters

DATE	EVENT NAME	AREA	TOTAL OBLIGATION ($ millions)
Oct-94	High Wave	RMI	0.95
Dec-92	T. Gay	RMI	6.26
Sep-92	H. Iniki	HI	229.26
Aug-92	T. Omar	Guam	63.35
Feb-92	T. Axel	FSM	0.76
Feb-92	T.S. Axel	RMI	2.79
Dec-91	H. Val	AS	77.17
Dec-91	T. Yuri	FSM	1.44
Dec-91	T. Zelda	RMI	5.67
Dec-91	T. Yuri	Guam	7.80
Jan-91	T. Russ	FSM	1.35
Dec-90	T. Russ	Guam	8.32
Dec-90	T. Owen	FSM	17.26
Dec-90	T.S. Mike	Palau	5.31
May-90	Kilauea	HI	12.38
Feb-90	H. Ofa	AS	26.68
Feb-90	T. Koryn	CNMI	2.14
Jan-88	T. Roy	CNMI	1.63
Jan-88	T. Roy	Guam	2.66
Jan-88	T.S. Roy	RMI	4.44
Jan-88	Floods	HI	5.55
Nov-87	T. Nina	FSM	15.85
Nov-87	T. Lynn	CNMI	0.36
Apr-87	Fire	RMI	0.18
Feb-87	T. Orchid	FSM	0.86
Jan-87	H. Tusi	AS	8.43
Dec-86	T. Kim	CNMI	12.04
Jun-86	T. Lola	FSM	0.48
Nov-82	H. Iwa	HI	8.46
Apr-82	Floods	HI	1.15
		Subtotal	510.77
		TOTAL	530.98

Roles in disaster preparedness and planning can best be described as a pyramid of increasing severity. At the base of the pyramid is local government and community organizations.

Local government provides the first line of response and is the level of government that is closest to the situation. Fire, law enforcement, search and rescue, and emergency medical services are provided by the local government to ensure life and property. Community voluntary agencies work in concert with the government to provide feeding, sheltering and basic needs of both individuals and families affected by the disasters. Additionally, private and government agencies work together to restore vital municipal resources, such as power, transportation and communications systems. If an emergency is so great that it overwhelms or exhausts local resources, assistance may be sought from the next level of the pyramid, state government.

State government has a duty to prepare for and respond to emergencies within their jurisdictions. State government serves as the liaison between affected populations and federal assistance programs. Should the disaster be so severe that it is beyond the capabilities of both the local and state government to respond, the governor, (or in the case of the Pacific Jurisdictions which has one level of government, the senior government official), may request a major declaration from the President of the United States. When such a declaration is made, a wide range of federal resources and assistance programs are made available to the affected state or jurisdiction. The federal response to an emergency represents the final tier of the pyramid.

The Federal Emergency Management Agency, or FEMA as described earlier, is the governmental agency which is responsible for coordinating response efforts when local and state resources are too heavily taxed.

The American Red Cross is the leading voluntary agency involved in disaster preparedness and response in America. Though not a government agency, the American Red Cross has a legal and moral mandate to provide disaster relief to the American people. American Red Cross' authority to respond to disasters is derived directly from its Congressional Charter of 1905.

The American Red Cross disaster services program involves the provision of a planning, preparedness, education and relief program throughout the United States and its

Territories and Possessions. American Red Cross disaster relief assistance involves the operation of shelters, the provision of feeding services, providing for individual and family assistance to meet immediate needs, such as the replacement of food, clothing and household items. American Red Cross assistance also involves medical health support, the handling of inquiries from concerned family members outside the area, and the coordination of relief activities with other voluntary agencies, businesses, labor and government. All American Red Cross disaster relief is provided free of charge and are a result of donations from the American public.

When responding to disasters, voluntary agencies provide resources to support the government's response efforts. For example, the American Red Cross supports government's efforts in mass care, by managing government identified congregate care shelters. Another voluntary agency, the American Amateur Radio Relay League (ARRL), provides emergency communications between government and voluntary agencies during disaster. Additionally, voluntary agencies like the American Red Cross coordinate the service delivery of other voluntary agencies involved in the response effort. Through a coordinated, collaborative effort government and the voluntary sector work together to address the disaster caused needs of their communities. Communication is a vital element of this coordination.

4.0. COMMUNICATIONS IN THE PACIFIC ISLANDS (REGION IX)

4.1. Telephone, Radio, Television

There are substantial telephone, radio and television frameworks in the major cities of the Pacific Island region served by FEMA. However, these infrastructures can not be depended on during an emergency due to frequent damage of telephone and electrical lines from the harsh weather conditions. High winds, flying debris and heavy rain have caused damage to overhead telephone and/ or electrical lines. If the public telephone system remains operational, it is also first to become overwhelmed.

4.2. Amateur Radio

Amateur radio communication is commonly used for communication in rural areas. Amateur radio communication is highly prevalent in the Pacific Islands. According the Federal Communication Commission, there are approximately 570 licensed amateur radio operators in Guam alone and another 500 total in the other U.S. territories and possessions in the Pacific. Amateur radio communication is used for voice and data applications. Due to the ease of installation and mobility of amateur radio equipment, amateur radio operation has historically been instrumental in providing communications in an emergency. Amateur radio communication infrastructures have often provided redundancy or replacement of conventional telephone communication. However it is evident, from past experience in both real time emergencies and unannounced drills, that there are factors, other than technical systems, to be considered. For example, there is a need for operators to be trained for emergency situations. There is a need for structure and organization of the voluntary groups to be able to actively and effectively support disaster relief efforts from the local to the federal level. Section 5.2 of this paper identifies how the Hawaii State Voluntary Organizations Active in Disaster, or HSVOAD, was formed in order to address these issues in Hawaii.

A high frequency radio costs approximately $1,500 U.S., with no recurring transmission costs. In the event of risk or loss of life or property, all local communication frequencies are made available for emergency communication.

4.3. PEACESAT

44 PEACESAT stations are located in 22 Pacific Island countries. As described in following sections of this paper, nine additional PEACESAT stations will be installed in each Emergency Management Office of the Pacific Island jurisdictions of

1012

Region IX establishing an Emergency Management Network. Additionally, in September of 1995, PEACESAT and the National American Red Cross entered into a Memorandum of Understanding confirming the commitment by each organization to work collaboratively in disaster relief efforts.

The PEACESAT system utilizes a decommissioned meteorological satellite, GOES-2, of the National Oceanic Atmospheric Administration (NOAA). Current PEACESAT services include voice, data and facsimile. A PEACESAT Services Improvement Plan is being implemented which will provide a digital overlay to the existing analog system. New services will include higher speed data, concurrent voice and data communication and compressed digitized video.

PEACESAT provides public service communication for distance education, training, research and economic development. Providing communication to support emergencies is also a primary mission of PEACESAT. In the case of an emergency, all scheduled programs are preempted to support the country in need of communication.

A standard PEACESAT station costs approximately $30,000 - $35,000 U.S. There are no recurring user fees in terms of transmission costs.

4.4 Inmarsat

Inmarsat-A systems are deployed for emergency response by American Red Cross. Inmarsat-A stations are portable systems which provide voice, data and fax transmissions via an Inmarsat satellite and Land Earth Stations. Inmarsat-A terminals provide a wide range of mobile coverage in all four ocean regions.

Currently there are two Inmarsat-A stations based in Hawaii, one in Guam and one in the Commonwealth of the Northern Mariana Islands. If an emergency occurs in other parts of the region, Inmarsat-A systems are brought in from either Hawaii, Guam, Saipan or the U.S. Mainland.

An Inmarsat-A terminal costs approximately $30,000 - $40,000 U.S. Transmission costs are approximately $10 U.S. per minute.

4.5. Military Communications

There are military communication networks in place which are primarily used to provide service to the armed forces of the government. These networks, understandably, cannot be readily depended on for dedicated civilian use. The military plays a major role in providing relief efforts during emergencies and require communication for their own needs. Security restrictions are also a concern for military communication networks.

5.0. EXAMPLES OF NETWORKS SUPPORTING

Emergency Communication
The Emergency Management Network utilizing PEACESAT and the Hawaii State Voluntary Organizations Active in Disaster (HSVOAD) are specific examples of emergency managers and communication network managers acting jointly to address the issues of establishing overlays of communication infrastructures to support emergency communications.

5.1. PEACESAT

The Pacific islands served by FEMA's Pacific Area Office correspond to the member States of the National Emergency Management Association's Pacific Caucus. The Pacific Caucus and the Governors of the AFPI, who also make up the Board of the Pacific Basin Development Council (PBDC), proposed to establish an Emergency Management Network (EMN) using the Pan Pacific Education and Communication Experiments by Satellite (PEACESAT) program. The EMN will strengthen emergency management planning, programming and response communication throughout the region.

The Department of Interior's Office of Insular Affairs and FEMA are jointly funding the

EMN through a cooperative agreement with the PBDC and PEACESAT.

The EMN will be made up of the Pacific Caucus Emergency Management Offices (EMO) in: American Samoa, Guam, Saipan in the Northern Mariana Islands, Majuro in the Marshall Islands, Kosrae, Pohnpei, Chuuk and Yap in the Federated States of Micronesia, and Koror in Palau. The Hawaii Civil Defense and the Pacific Area Office will be able to access the PEACESAT network via a phone-patch to the PEACESAT Headquarters located at the University of Hawaii.

Each earthstation will consist of a an analog transceiver, a 3.5 meter satellite dish, and a radome. PEACESAT earthstations share the use of nine analog simplex channels that support voice teleconferencing and three full-duplex point-to-point channels for voice, fax or data transmission. One full-duplex and one simplex circuit will be dedicated to the EMN.

The full-duplex channels support 9.6 Kbps data communication for data transfers or access to information services such as Internet. PEACESAT headquarters in Honolulu provides Internet access to the Pacific via GOES-2. The PEACESAT standard terminal can be upgraded to support higher data rates up to 32 Kbps.

All standard PEACESAT stations are equipped with a telephone patch which can connect calls from the public switched telephone network to the PEACESAT network. This would be practical for a location outside of the GOES-2 footprint, Washington D.C. for example, to be in direct contact with the EMO facing the crisis. If Saipan was completely devastated without telephone communication, electricity, etc. the EMO would contact another PEACESAT station, Honolulu, for example, who would then "phone-patch" the appropriate federal office for a current status of the situation and needed resources.

PEACESAT systems have withstood environmental disasters in the Pacific. Recent examples include Hurricane Iniki and Typhoon Omar. Historically, PEACESAT has provided communication to devastated areas when telephone lines were either completely disabled or overloaded. However the EMN intent is to combine several integral components that will provide the basic structure to better orchestrate disaster planning and relief assistance.

The EMN calls for the PEACESAT antenna to be housed in protective radome coverings for an added level of protection and will allow communication during the storm. Theses PEACESAT stations will be equipped with back-up power, sturdy facilities and personnel who are readily available and trained to operate under emergency situations.

The EMN will be instrumental in assisting FEMA to fulfill its response and recovery, preparedness and training, and mitigation roles in the Pacific. The EMN will provide a reliable, survivable communication system during and after a disaster. This will allow FEMA to respond to a disaster quicker and more appropriately, to overcome the large distances and high cost of travel that impede staff training and education, and to provide information on a timely basis.

5.2 HSVOAD

In the wake of Hurricane Iniki, which in 1992 devastated Hawaii's Northernmost island of Kauai, it was clear that an collaborative and cooperative disaster response effort on the part of government and voluntary agencies was required. However, the desire to coordinate the various disaster relief programs became an almost impossible task as conventional communication systems were disrupted, over taxed or destroyed along with approximately half of Kauai's 20,000 homes and most of its 70 hotels. Over 7,000 of Kauai's 52,000 people were left homeless.

In retrospect of the Iniki experience voluntary agencies, realized that a more coordinated effort among Hawaii's communities must be developed to insure a more efficient disaster response effort in the future. As a result, on July 27, 1993, the

Hawaii State Voluntary Organizations Active in Disaster, or HSVOAD was formed.

The mission of the HSVOAD is to "facilitate the provision of comprehensive services to the People of Hawaii in disaster preparedness, response, and recovery by fostering coordination among private, non-profit and government agencies". The emergency management objective of HSVOAD is to "ensure a collaborative, effective, and timely disaster response among volunteer organizations". In an emergency situation, when the State of Hawaii Civil Defense Emergency Operations Center (EOC) is activated, a member of the HSVOAD is assigned to the EOC team. The HSVOAD representative within the State EOC will respond to operating requirements of the State Director of Civil Defense, State and County government requests for coordination and disaster assistance, as well as from HSVOAD member agencies. With such an important role to play, the HSVOAD realized early on in its formation that a reliable cost-effective communication system was needed to insure continuity of communications during and after a disaster.

Training and practice is essential in forming an effective emergency operations routine. In March of 1995, an initial emergency test using volunteer amateur radio operators and CB stations was conducted specifically to aid the HSVOAD organization. Communication links were set up by amateur radio operators and CB operators at the HSVOAD member agency offices.

The emergency communications test operated within a pre-determined scenario that called for a near miss hurricane that left wind and major flood damage in West Maui and the Southern Region of Hawaii County. There were ensuing problems related to food, shelters, and mass care. The emergency communications network, or HSVOAD-NET, was activated to address these various concerns.

In all, ten HSVOAD sites on four islands came on-line. The test proved without a doubt that a designated voluntary agency emergency communications system was an absolute necessity and completely feasible. To further validate the existence of a voluntary agency emergency communications system, the HSVOAD-NET was activated during the State of Hawaii 1995 Hurricane Exercise. During the May exercise, all twenty-five HSVOAD member agencies expressed interest to participate. Unfortunately there were not enough CB and Amateur radio operators available to support their involvement. To address this issue, the HSVOAD made arrangement to phone patch or CB patch voluntary agencies into the emergency communications net, via the MARS communications systems. Thus, HSVOAD agencies that did not have an on-site amateur radio operator were able to participate and communicate. Those voluntary agencies that actively participated were serviced by amateur radio operators equipped with hand-held portable radios. Additionally, voluntary agencies located in areas not conducive to VHF transmission, (high rise buildings), were serviced by CB operators. During the hurricane exercise, HSVOAD member agencies and the local governments were successful in using the given scenario and resources to create a workable communication solution. From this exercise, the HSVOAD and related players will be in a better position to respond proactively rather than reactively, in the event of an actual hurricane.

The beauty of the HSVOAD-NET is that the system utilizes existing training systems and volunteer structures. The system is not complicated and is "user-friendly", with the option of transmitting voice or data information. Also, in the event that a voluntary agency would like to transmit and receive its own communications, a portable-hand held VHF radio can be purchased for $300 or less. Voluntary Agency staff can train themselves to be systems operators by completing the ARRL home study course and applying for a Ham Radio License. The ability to "self-train" and procure affordable equipment makes HSVOAD-NET very cost effective. Supporting the HSVOAD-NET are existing "repeaters" operated and owned by private radio clubs and state government, providing instant state-wide coverage.

It should be noted that HSVOAD intends to work with member agencies like the ARRL, the American Red Cross and PEACESAT to further develop redundant communication systems that can enhance the HSVOAD-NET. A few desirable developments would include interfacing HF and VHF networks to satellite communication for extended coverage, portable satellite systems and packet data communications via HF or VHF radio to be interface to satellite terminals for data communication from rural areas.

HSVOAD is dedicated to the continued development and utilization of redundant methods of communication during times of disaster.

6.0. CONCLUSION

Emergency management communication for planning, response and relief efforts, are currently being addressed by emergency managers and organizations, who are joining forces with various communication networks with the intent of providing redundant, reliable and survivable communication in the Pacific areas.

It is evident that there is a need to identify communication systems that are in place and identify innovative means of strengthening these infrastructures by considering alternative power (solar power repeaters, generators, etc.), overlapping system applications with redundancy, organizing the information flow and management of the networks to best serve the emergency communication needs.

With systems and networks in place, it is critical to provide operators with proper training and practice. Routine emergency communication network drills involving all parties likely to be involved will do many things: It will verify the operational condition of the communication equipment if not used on a regular basis exercise operational procedures and maintain collaborative relationships.

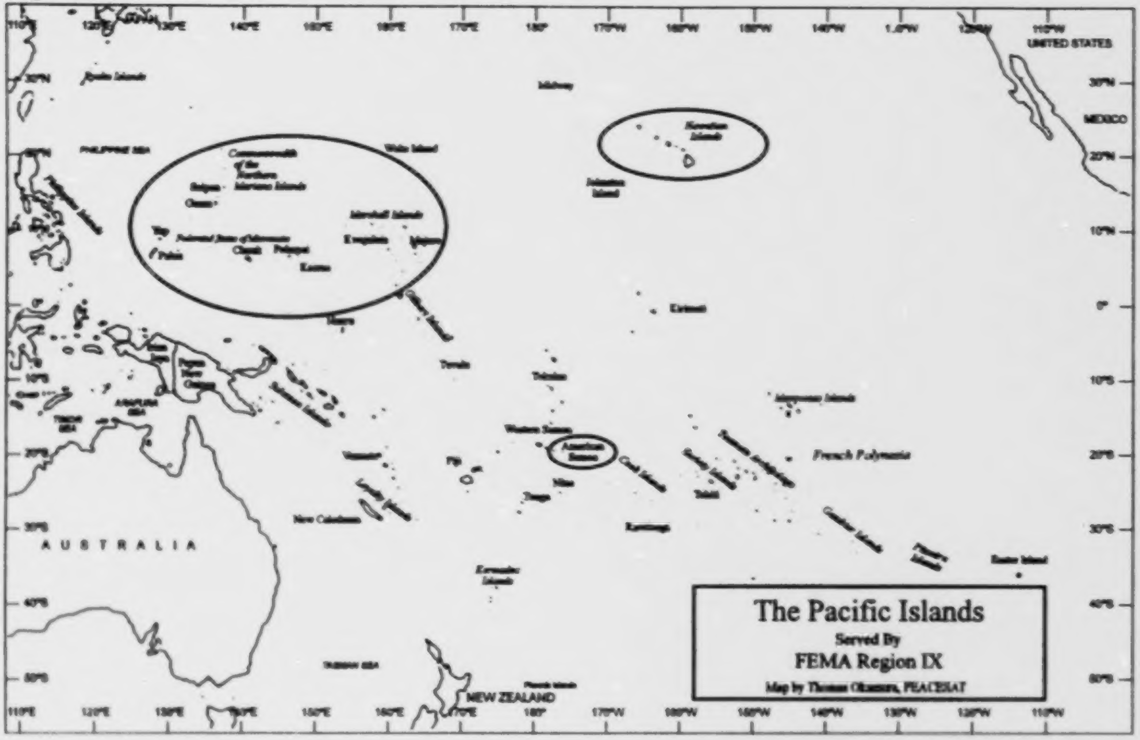
There are numerous efforts working parallel to these which are not mentioned in this paper. They include information delivery systems to reach the masses specifically for disaster preparedness. For example, systems which can transfer and distribute weather images and information for advanced warning and proper preparation. An example is the Radio Activated Alarm System (RAAS) developed by the Scientific and Commercial Systems Corporation. It is a hand-held system which receives warning alarms indicating danger. It is intended to provide wide range of coverage with various types of repeater systems attending specifically to rural areas. There are many innovative applications for a system such as the RAAS.

Communication technology is ever changing and developing. Emergency managers must push communications technology to the limit. It is a challenge we can ill afford to ignore and that requires organizations to work together and join resources.

ACRONYMS

AFPI	American Flag Pacific Island
ARC	American Red Cross
ARRL	American Amateur Radio Relay League
CB	Citizen Band
DOI	Department of the Interior
EEZ	Exclusive Economic Zone
EMN	Emergency Management Network
EMO	Emergency Management Offices
EOC	Emergency Operations Center
FEMA	Federal Emergency Management Agency
FSM	Federated States of Micronesia
GOES-2	Geostationary Operating Environmental Satellite
HF	High Frequency
HSVOAD	Hawaii State Voluntary Organizations Active in Disaster
MARS	Military Amateur Radio System
NMI	Commonwealth of the Northern Mariana Islands
NOAA	National Oceanic Atmospheric Administration
PBDC	Pacific Basin Development Council
PEACESAT	Pan Pacific Education and Communication Experiments by Satellite
RMI	Republic of the Marshall Islands
RAAS	Radio Activated Alarm System
VHF	Very High Frequency

Figure A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Midway
Hawaiian Islands
Marshall Islands
Kiribati
American Samoa
French Polynesia
AUSTRALIA
NEW ZEALAND
The Pacific Islands
Served By
FEMA Region IX
Map by Thomas Okamura, PEACESAT

THE FUTURE OF PRIVATE SUBMARINE CABLE: NEW CABLES AND ECONOMIC OPPORTUNITY

Neil Tagare, Vice President, Marketing and Business Development, FLAG Ltd., USA

It gives me great pleasure once again to participate in the eighteenth annual Pacific Telecommunications Conference. This forum provides an excellent opportunity to keep up-to-date on the changes continually occurring in the rapidly evolving world of telecommunications.

This is the fifth year in a row that I am representing FLAG at PTC. This year I would like to briefly mention FLAG and then move on to the future of the submarine cable industry as I see it.

The most salient feature of FLAG was that this was the first ever project financing of a submarine cable and probably the most complex financing in the telecommunications industry. More than 30 financial institutions from all over the world participated in this venture. FLAG is the first submarine cable project to have received political insurance from the US-Exim and MITI of Japan.

I am not going to discuss FLAG's future strategies, however, I would like to discuss my personal views of the submarine cable industry. As a matter of fact, I am also writing a book titled "The road ahead: Future of the submarine cable industry" and I hope to publish it by the end of 1996.

I believe the future is very bright for this industry. In fact, this is just the beginning of at least a decade of double digit growth. I admit there are many skeptics who do not believe that such a growth rate is sustainable, especially considering the overcapacity of circuits existing on certain routes. By the end of this presentation I would like to present my case as to why I believe otherwise. I would also like to prove that private submarine cables are here to stay and will be the preferred solution in the future.

There are several trends shaping the international communications industry. Chief among them is the Internet. The Internet has the potential to change the rules of the game completely. In the next decade, a host of new players with completely new business plans and agendas will attack the business. Their emphasis will shift from providing "dumb pipes" to "value-added" services. Quality of content will be the key driver in the future as opposed to brute economic force or quantity of traffic.

Even today, software programs are available that allow users to talk through their computers on the Internet. A friend of mine who pays only a $15 per month flat fee for Internet access, talks to his parents in Indonesia for hours. What will happen to the revenue stream of carriers worldwide if everyone starts using the Internet to make international phone calls?

The second trend that will reshape this business is that the current model based on accounting rates will break down. The telecom model will shift to a model based on the airline industry where a carrier, by virtue of its presence, will not be guaranteed a monopoly in its market. This will also result in significant pricing pressure and a need to differentiate between carriers based on "quality of service and content." It is possible that a group of carriers will start offering Lotus Notes or other groupware through their "smart" pipes and offer their customers an Intranet service for specific groups or companies.

In addition, most countries will have multiple "licensed carriers." Even though Chile is an extreme example of competition gone wild, a similar situation in many countries is not unforseeable.

Domestic competition combined with "unlicensed" competition from refilers, call back services, credit card services and bypassers will put even more pricing pressure on operators.

A final trend is the globalization of business as never seen before and the shift of this business from a manufacturing base to a service base. With the signing of GATT and other trade agreements, service industries in most countries will soon be open for competition.

All of the above trends point to a common direction for future international carriers, operators, PTTs, Internet Service Providers, and other competitors: they have to find the best quality and the cheapest source for circuits, add value to those circuits and compete with each other.

In the past, a few large carriers such as AT&T, British Telecom and France Telecom have taken the lead to underwrite major cable projects. This model works as long as the accounting rate structure is intact. As soon as the model breaks down and there is full fledged competition between operators, underwriting of large projects will come to a standstill.

That's when a private carrier's carrier such as FLAG can fill in a void. A private cable operator does not own any cable ships, nor does it manufacture cable or electronics. Supporting a private cable operator who does not compete with any of the carriers will be politically and commercially an acceptable solution worldwide.

Spread of the Internet worldwide will put pressure on carriers from very small countries such as Mauritius, Papua New Guinea, and Seychelles to join the fiberoptic web. If these countries have the same communications technology as the Western countries, they will be able to compete in the new era. A popular website in Burundi could have more hits than a website in a country ten times larger. Telephone operators will invest more time and money in encouraging creativity and adding intelligence in their network. Commodity traffic such as voice will be almost free. Operators will make money by adding value to the traffic and by using sophisticated database techniques to market other products to their customers. Revenue stream from database marketing activities could exceed revenue from commodity phone calls.

Operators will develop specialization for their countries: for example, Ireland and the Caribbean countries will want to be the "telephone operators" of the world, Philippines and India will compete for data processing jobs, India will want to be the world leader in client server software. Telephone companies will develop alliances and joint ventures with certain industry groups for mutual benefit.

Internet along with fiberoptic cable will take this concept even further for small countries. For example, with the right technology in place, Gibraltar could become the global casino center on the Internet. Bermuda, already a tax haven and a re-insurance leader, could extend its leadership in this area on a global scale. Countries will rise or fade based on their telecommunications expertise and quality.

Bringing entire continents and countries in to the mainstream of state-of-the-art telecommunications will be a challenge of the industry. Fiberoptic cable in general and private submarine cable in particular will help countries to quickly get on the map. The challenge is not only to just build these cables but to put together a commercial package that makes it economically feasible for these small countries to be connected globally.

Companies that can integrate these small countries in to the Worldwide Fiberoptic Web will reap significant rewards.

Mid-Range Undersea Cable System Applications for Emerging Markets

Kathleen A. Kurek and Elin C. Upperco
AT&T - Submarine Systems
Morristown, NJ USA

1. ABSTRACT

Requirements for undersea cable systems have traditionally been driven by the needs of the transoceanic systems. These traditional systems have been designed and optimized for long-haul performance. With the needs of domestic and regional markets increasing, the requirements for undersea cable systems have grown to adapt to these mid-range applications. Newly designed, mid-range undersea cable systems are developed with this customer need at the forefront. As such, these mid-range undersea cable systems have a much stronger emphasis in networking and connectivity than their long haul predecessors

2. INTRODUCTION

With the demand for world wide communications increasing, an emerging trend of seamless integration of the global communications network with the local infrastructures is dominating the requirements for new communication products. This paper will examine how the undersea telecommunications market is expanding to include the regional and domestic end user customer, and the effect this has on opportunities in these arenas. As the needs for connectivity and growth into the global network expand, the linkage between the embedded base of the regional and domestic telecommunication markets with the international network of undersea cable systems becomes a significant driver of undersea cable system product requirements.

A large majority of this growing opportunity falls into mid-range rather than transoceanic undersea cable solutions. Requirements for undersea cable systems have traditionally been driven by the needs of the transoceanic systems. These traditional systems have been designed and optimized for long-haul performance. With the needs of domestic and regional markets increasing, requirements for undersea cable systems have grown to adapt to these mid-range applications. Newly designed, mid-range undersea cable systems are developed with this carrier need at the forefront. As such, these mid-range undersea cable systems have a much stronger emphasis in networking and connectivity than their long haul predecessors. The following is a framework for developing system solutions with undersea cable system architectures that includes a mid-range product which is optimized for short haul, predominantly network solutions.

3. MARKET OVERVIEW

Growth over the next 2 to 5 years in the domestic and regional marketplace is forecasted to be tremendous. This explosion in opportunity is due to many political, economic and technological trends which will be explored briefly here.

As we move towards a more global economy, there is greater need by smaller countries to develop and expand their domestic facilities into networks that can grow and ultimately gain access into transoceanic trunks. As more of the regulations that once constrained entrants are lifted, interest and participation in undersea telecommunication systems by private telecoms, businesses, and investors has increased. Privatization, the formation of regional alliances and trade agreements, and continued deregulation in the international telecommunications market also contribute to greater demand in the domestic and regional marketplace. Now other countries can and want to invest in modernizing and expanding their existing terrestrial telecommunications systems. By focusing capital on bringing in new and improved communications services, developing countries are also more likely to attract the business of multinationals who bring much needed foreign capital to continue infrastructure improvements and the push towards globalization.

Mid-range undersea cable products fill many of the needs of the domestic and regional carrier by allowing them to seamlessly and cost effectively integrate with the global network architecture. To understand the unique needs of the domestic and regional carrier one must first understand how these markets fit into the global network. A market segmentation of undersea cable systems within the global network architecture is next discussed.

4. DOMESTIC & REGIONAL SYSTEMS IN THE GLOBAL NETWORK

The global network is structured here into three segments or tiers. The three tiers are: the global or transoceanic, regional and domestic. Each tier is defined by a unique position within the global network. Each tier is associated with a unique set of carriers who have their own unique requirements.

The large global or transoceanic tier connects geographical regions usually spanning oceans. The predominant players in this market are the large global carriers. Systems in this tier are mostly high capacity trunks, the back bones of the global network.

The regional tier connects countries within a geographical region. Systems within this tier usually serve to distribute traffic from city hub to city hub and to aggregate the traffic into branches connecting into the trunks of the global tier. Because these applications are international, physical distinction and security of traffic is often desired.

The domestic tier connects population centers within a country or islands near a country's mainland. In this tier, national carriers are primarily interested in providing services to satisfy their nation's need for local connectivity, and to support continued growth and expansion into interregional systems. Undersea cable solutions in this tier may be more economical and physically secure when compared to comparable terrestrially provided connectivity.

The various tiers drive different requirements that can be met with a variety of product and system architecture combinations. The customers in each of these tiers will have their own perspective on what is most important to them in a system solution. In the next section, a framework for developing these system solutions from the customer's requirements is discussed.

5. DEVELOPING SYSTEM SOLUTIONS

Potential customers enter into the telecommunications market with needs or requirements they wish to be satisfied. These requirements are defined here in terms of eight basic system attributes: expandability, compatibility, upgradeability, network management, sovereignty, maintenance, robustness and restoration. Definitions of these attributes can be found in the glossary.

These basic attributes can be fulfilled via a number of architecture and product combinations. Each potential solution offers a unique value to the customer. The total value (V) of a solution can be defined as the weighted sum of the three basic value elements of quality (Q), cost ($) and time (t), where Q may stand for system performance (including features and functionality) and/or reliability, cost for purchase price and/or financing, and time for availability. The weights (w1, w2, w3) applied to each value element are unique to the customer and come from that customer's relative prioritization of Q, $ and t. The diagram below shows pictorially how this system solution model works:

This framework is now used to examine the unique needs of the domestic and regional carrier, and the ability of various system architectures in combination with a mid-range repeatered product family to provide solutions of the greatest value to this customer.

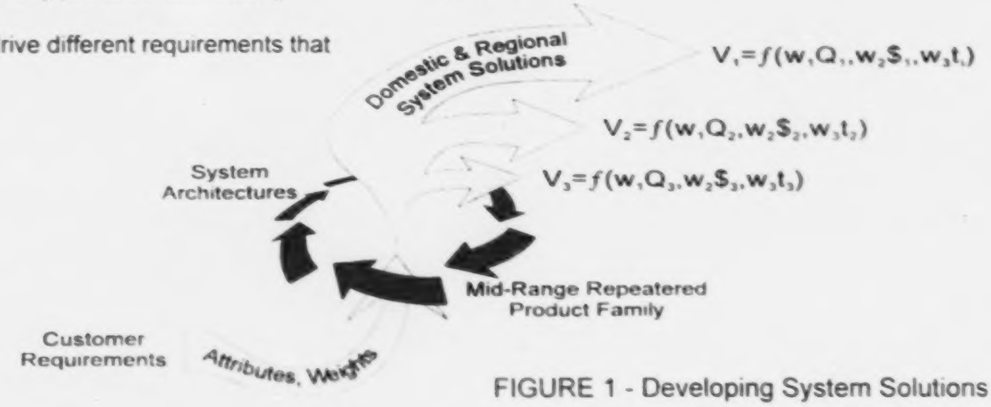

Domestic & Regional System Solutions
$V_1=f(w_1Q_1,w_2\$_1,w_3t_1)$
$V_2=f(w_1Q_2,w_2\$_2,w_3t_2)$
$V_3=f(w_1Q_3,w_2\$_3,w_3t_3)$
System Architectures
Mid-Range Repeatered Product Family
Customer Requirements
Attributes, Weights

FIGURE 1 - Developing System Solutions

6. CUSTOMER REQUIREMENTS IN THE DOMESTIC & REGIONAL MARKET

The needs of the carriers in this growing sector are very different from those of the more traditional transoceanic market: the regional and domestic carriers need system solutions that allow them to grow in a flexible, compliant, and economic fashion.

Many of the customers in the domestic and regional markets will have existing terrestrial communication systems that they are looking to extend via undersea cable systems to build new domestic or regional networks. In addition, many may not be able to predict long term connectivity or capacity needs. These carriers therefore want a product that provides them with a complete and seamless interface with what they already have (***compatibility***) and the ability to grow as their system capacity and networking needs evolve (***expandability, upgradeability***).

The number and location of the customer's required landing points will determine the customer's need for ***sovereignty*** and ***network management***. In general, though, there will be greater need for the physical security of transmissions in regional networks that bridge nations rather than in domestic systems that connect cities within a single country. Network management is important in both domestic and regional systems because it provides the carrier with centralized operation and maintenance functions for their cable systems as well as the interfaces to their embedded terrestrial base.

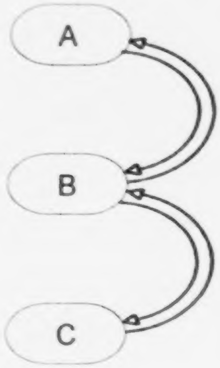
The up-front purchase costs of undersea fiber optic cable systems will be crucial for the customers in this market; much more so than in the transoceanic market where the "customer" is most often a large, international consortia. They will look upon buying a undersea cable system as a major, once in a lifetime purchase. Transmission facilities mean revenue, and these carriers may not have as many options as are available to transoceanic carriers to restore service via satellite, terrestrial or other undersea cable should their system need repair. Therefore, ***maintenance***, ***robustness***, and ***restoration*** will all be important.

The ability of a system solution to support these attributes depends on both the architecture and product choices made. The three most basic undersea cable architectures are next analyzed in terms of their relative abilities to meet these key customer requirements.

7. ARCHITECTURE TRADEOFFS

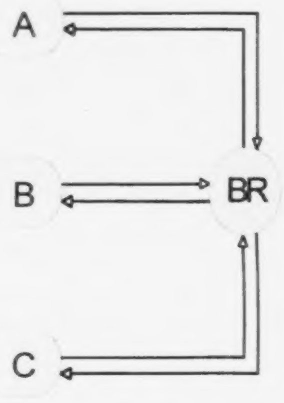
Undersea cable systems support several basic architectures, each one offering a unique set of features. Three architectures are presented below with a bullet list of their basic advantages and disadvantages in meeting the generic system requirements of expandability, compatibility, upgradeability, network management, sovereignty, maintenance, robustness, and restoration.

7.1 POINT TO POINT AND FESTOONS:



- scaleable
- intermediate stations require back to back equipment configurations; land shore installations tend to be more labor intensive
- likely to have more elements to manage because of number of cable stations
- all traffic travels through all nodes so a single point failure bisects the system
- failure dictates ship repair

7.2 TRUNK AND BRANCH

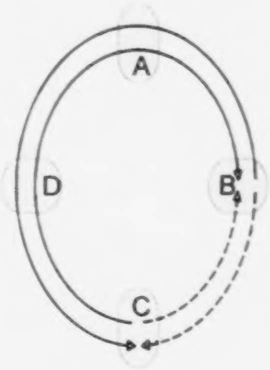


- increased route diversity over festoon; however, expandability of system is more difficult. More upfront planning is required to meet final capacity needs.
- branches allow more diversity

in routing to bypass nodes if desired
- some simplification over festoons in the number of elements to be managed
- branch failures isolate single nodes only; however, with no inherent ability to restore upon itself, a system trunk failures would bisect the system

7.3 RINGS

- much network management capability already embedded in the ring terminals
- all traffic travels through all nodes
- redundancy in traffic allows testing and maintenance functions to be performed without disrupting service
- single point failure prompts use of alternate route thus allowing maximum availability



In Table 1 (attached), these three architectures are rated relative to one another on their abilities to support the eight basic system attributes. In this comparison, festoons appear to be the most vulnerable of the three architectures, with rings rating on par or higher in the majority of categories. However, the total merit of a solution is not determined singularly on the choice of architecture. The features of the product choice must also be considered.

In the next section, the features of a mid-range repeatered product are presented. Emphasis will be on how existing transmission products (terrestrial and transoceanic undersea cable) can be optimized for the needs of the domestic and regional carrier.

8. PRODUCT REQUIREMENTS AND CAPABILITIES

With the focus on the regional and domestic systems, the mid-range product features are typically optimized for system lengths between 300 and 1500 kilometers. In engineering these systems, design optimization and feature/functionality focus occurs in both the wet plant and the dry plant. See Figure 2.

The WET PLANT is focused on the cable and repeater designs. The wet plant designed for transoceanic distances is suitable to mid-range system applications. However, some optimization of the wet plant to take advantage of the shorter network and segment spans is possible.

Cable -No significant changes to the basic product design, although shorter and often more shallow spans utilize larger percentages of armored cable varieties.

Repeater -With the current optical amplifier technology, use of high gain optical amplifiers allow repeater spacings to be maximized for shorter spans.

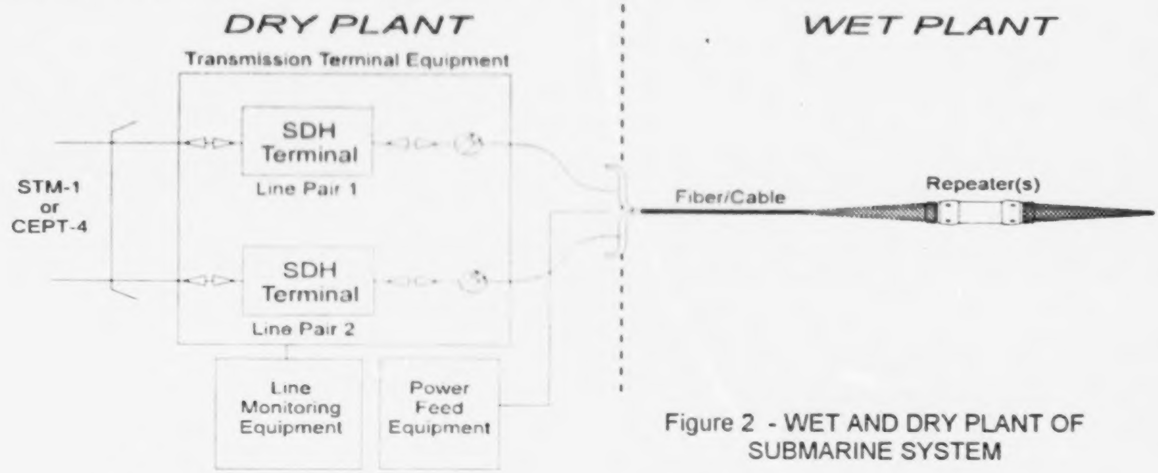


Figure 2 - WET AND DRY PLANT OF SUBMARINE SYSTEM

The DRY PLANT focuses on the terminal equipment, including the operations and maintenance systems. With connectivity as a primary driver in this market, features of terminal equipment to support growth, flexibility, and networking are key. With greater need to tie together and coordinate multiple terminal stations, increased network management functionality is desired.

Terminals -Requirements for less sensitive optics allow more flexibility with the choice of terminal transmitters

-More demand for equipment moving further into terrestrial network (cross connects, low speed interfaces and multiplexers) forcing increased terminal standardization

-More need for feature and functionality to support networks: add-drop capabilities, line and protection switching

-Increased requirements for upgradeability met through terminal upgrade and enhancement (e.g., Wavelength Division Multiplex-WDM)

-The need for seamless integration with other embedded systems drives the need for equipment standard at interfaces

Power Feed Equipment (PFE) -Shorter systems segments allow for usage of lower voltage powering requirements, thereby creating an opportunity for a lower cost, lower voltage PFE

-Features can be simplified

Operations, Administration, and Maintenance (OA&M) -With the current optical amplifier technology, the monitoring of the undersea plant can be performed via bit rate independent Line Monitoring Equipment (LME), thereby allowing more flexibility when upgrading the system.

Network Management -With the complexity of integrating many systems, Network Management Systems require the ability to handle more elements through a centralized location.

9. MID-RANGE REPEATERED PRODUCTS BRING VALUE TO THE DOMESTIC & REGIONAL MARKET

Global communication is vital to the growth of any country. Access to the information highway is provided through the means of various systems, all of which play an integral part of the global network. Undersea cable systems continue to provide high capacity, flexible, and secure telecommunications links. The unique needs of the fast growing domestic and regional sector can be efficiently and effectively met with a mid range repeatered product family.

System solutions can take the form of numerous combinations of product and architecture, each offering unique value. The optimum system solution depends upon the customer's personal weighting of the three basic elements of value (price, performance, and time, and how well the solution fulfills the customer's needs. Customer needs were defined in terms of basic system attributes: expandability, compatibility, upgradeability, network management, sovereignty, maintenance, robustness, and restoration. Three basic system architectures were then analyzed for their relative ability to meet these attributes. Lastly, high level product and feature optimization for domestic and regional applications was presented by major subsystem categories.

The development of a mid range repeatered product focuses more specifically on the needs of the domestic and regional carrier. Further, by gleaning out and optimizing where needed, this product family can be defined almost entirely from a foundation of existing, both submarine and terrestrial, telecommunications products.

RELATIVE ABILITY OF BASIC ARCHITECTURES TO SUPPORT SYSTEM ATTRIBUTES

SYSTEM TYPES SYSTEM ATTRIBUTES	POINT TO POINT AND FESTOON	TRUCK AND BRANCH	RING
Expandability	+	=	-
Compatibility	=	=	=
Upgradeability	-	=	=
Network Management	-	=	+
Sovereignty	-	+	-*
Maintenance	-	=	++
Robustness	--	=	+
Restoration	-	-	++

Table 1

* The Africa ONE Network ring architecture is an exception here as it employs state of the art WDM branching units to isolate dedicated traffic to cable stations thus providing optimum traffic security.

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GLOSSARY

EXPANDABILITY - ability to incorporate additional nodes to the network after the initial installation

COMPATIBILITY - ability of a network to be designed compliant with standards to allow seam less integration with the domestic embedded base

UPGRADEABILITY - ability and ease with which a network can increase its capacity

NETWORK MANAGEMENT - number and complexity of elements to be managed

SOVEREIGNTY - number of nodes traffic must pass through before final destination

MAINTENANCE - ability to manage routine and extraordinary maintenance procedures while keeping the system in service

ROBUSTNESS - ability of a system to withstand single point failures without the need of a ship repair

RESTORATION - ability of a network to be restored on itself following station failure or a cable cut

Fiber Optic Submarine Cable Systems: An Opportunity for Emerging Markets to Access the Global Highways and Super Highways

John Warta
GST Telecommunications, Inc.
Vancouver, Washington

1. Abstract

The construction of submarine fiber optic cable systems as a transmission medium has enhanced the quality and variety of global telecommunications services while increasing competition, reducing prices and perhaps most significantly stimulating overall economic growth. This paper presents a rationale for emerging markets to pursue the construction of fiber optic cable systems as an engine of economic development and highlights existing and proposed cable systems offering connectivity to Latin America. This paper also identifies certain issues that developing countries should consider as they develop policies regarding the construction of fiber optic cables within their national boundaries.

2. Introduction

It is well-established that a strong telecommunications infrastructure is critical for any country to gain access to the global information highways and superhighways that facilitate the flow of goods, services, and even people among countries worldwide. Because of its trademark high quality, capacity, security, reliability, and comparatively low cost per circuit, for the past decade developed countries around the world have relied heavily on fiber optic technology[1] and submarine fiber optic cable systems as the transmission medium of choice to link their economies. Following the lead of economic giants around the world, as they open their markets to competition, emerging countries throughout Latin America are beginning to participate in international fiber optic cable consortia to ensure regional connectivity and access to the world's major economies.

Fiber optic cable systems not only achieve the goals of global and regional connectivity for developing countries in Latin America, they present an opportunity for these countries to safeguard their communications infrastructure from the perils of seasonal hurricanes and tornadoes, and to leap-frog their existing antiquated terrestrial infrastructure into the 20th century with a comparatively minimal investment in advanced technology. As the experience in the U.S. market demonstrates, the development of a strong competitive telecommunications markets serves as an impetus for investment in communications infrastructure that will provide high-capacity, reliable and secure communications such as fiber optic cable systems.

3. Rationale for Constructing Fiber Optic Cable Systems

Since the early 1980's, many Latin American countries have initiated efforts to privatize their telecommunications sectors as part of debt reduction programs. To date, countries such as Argentina, Chile, Mexico and, most recently, Peru have implemented such programs. Many other countries in Latin America, including Ecuador, Nicaragua and Panama are contemplating similar programs. With privatization of the national telephone companies, the new owners/operators, often led by U.S. and European telephone companies, assumed significant investment obligations to upgrade and expand the existing telecommunications networks.

Because of the low telephone penetration,[2] however, infrastructure investment is intended to expand capacity for basic telephone service rather than to introduce new, enhanced services that drive much of the investment in developed countries. With this primary goal, many telephone companies throughout Latin America have opted to invest in new, advanced technologies that can be upgraded to gain access to global markets. The construction of submarine fiber optic cable systems has been an integral part of this push towards a higher quality and more efficient telecommunications infrastructure. Most of the region's telephone companies have joined consortia to build submarine cables that will provide connectivity not only among the Latin American countries, but also with Europe and Asia. In the early 1990s, private funded cable systems have emerged to augment the carrier based systems and increase market penetration through resale of their capacity to carriers.

As depicted by the U.S. experience, many benefits accrue to countries connected by fiber optic cable systems. In addition to the immediate benefits that accrue to owners of fiber optic cable systems, such increased transmission capacity and reliable telecommunications circuits, fiber optic cable systems also contribute long term benefits such as economic growth, increased flow of hard currencies, creation of jobs, and overall development of a reliable telecommunications infrastructure that promotes the development of high-tech industries.

Over the long term, submarine cables also contribute to the development of competitive international telecommunications markets. In particular, the additional and reliable sources of capacity, at competitive prices, have allowed the telecommunications resale market to flourish in the United States. Resale competition, can provide important public interest benefits. The most obvious benefit to consumers is that resale competition promotes price competition in telecommunications services, encouraging facilities-based carriers to price their services close to costs. Further, the presence of resale competitors encourages competition in service quality and alternatives. Many resellers provide special service enhancements ranging from customized billing to systems integration and telecommunications consulting services that help their customers optimize their use of telecommunications services to grow their business and promote economic development. Thus, resale brings the price and service quality benefits of competition to a larger population than would be the case if the elimination of resellers resulted in an oligopoly composed of a handful of large facilities-based carriers. Resale of telecommunications services also provides an alternate source of funding which accelerates fiber system provisioning in instances where infrastructure growth is stalled because major funds are required elsewhere.

4. Submarine Fiber Optic Cable Systems Serving Latin America

4.1 The Unisur System

The Unisur system stretches 1,714 kilometers along the southeastern coast of South America linking Las Tolinas, Argentina, with Florianopolis, Brazil, and Maldonado, Uruguay. The Unisur system has the capacity to carry as much as 560 million bits of information per second -- equivalent of 40,000 simultaneous phone calls over one working pair of optical fiber or one spare pair. The second fiber pair can be activated in the future to accommodate traffic growth in the region. The system is significant because it connects -- through a land-based fiber optic link -- with the Americas-1. The same land based link also connects Unisur with the Columbus-II transatlantic fiber optic cable system, providing countries in Latin America with a continuous fiber optic highway to the Caribbean, North America and Europe.

4.2 The Americas-1 System

The Americas-1 is an 8,000 kilometer undersea cable system that links the United States, the Virgin Islands, Brazil, Trinidad and Venezuela that became operational in 1994. The system was built to complement Latin America's existing and planned land and undersea fiber-optic cable systems to provide regional and international networking. The Americas-1 connects to Taino-Caribe, a 187 kilometer repeatered undersea cable system that provides intra-regional communications to Puerto Rico and Tortola. In Brazil, a terrestrial cable will connect Americas-1 to Unisur. In addition, the Americas-1 provides connectivity with Europe via the Columbus-II system, to which the Americas-1 connects in St. Thomas.

4.3 The Columbus II System

The Columbus II system, which became operational in 1994, is a high capacity digital submarine cable system that links the United States, Mexico, the U.S. Virgin Islands, Spain, Italy and the Grand Canaries. The Columbus II fiber optic cable, completed in 1994, stretches 12,200 kilometers and has a capacity of 23,000 telephone channels through which 90,000 simultaneous calls can be transmitted. Telefonos de Mexico ("Telmex") is the majority shareholder in the venture.

5. Proposed Cable Systems

Submarine cable systems have also provided an economical and expeditious way of providing national connectivity in countries comprised of archipelagos or with large coastal areas with inlets. In particular, unrepeatered submarine systems ("USSs") have been used by countries such as Italy, Thailand and Norway, which have long strings of major coastal towns and a mountainous terrain, to link each town together in series by using a number of concatenated coastal USSs ("festooning").

The same festooning approach is being planned for some Latin American countries where submarine cables will be used to provide connectivity to third and fourth tier cities which would not otherwise connect with to the national network. Such is the case in Mexico where a submarine cable system along Mexico's Pacific coast that will connect several smaller cities is currently under serious consideration.

Some of the larger systems include:

5.1 Mexico's West Coast Submarine Cable System

As currently proposed, the Mexico festoon would land on Mexicali, San Luis, Guaymas, Topolobampo, Altat, San José del Cable, Mazatlán, Puerto Vallarta, Colima and Acapulco and connect from Puerto Vallarta and Acapulco to Guadalajara and Mexico City respectively through a terrestrial fiber optic link. Unlike, the major international carriers (AT&T, MCI, Marcatel) that are concentrating on building their fiber optic networks to connect the three largest cities (Mexico, Guadalajara and Monterrey), the submarine cable system would bring fiber optic connectivity to several second and third tier cities which would not likely be immediate candidates for cable systems. The submarine cable will also eventually connect with the Pan American Cable Submarine System through a connection to Panama and provide access to the Asian networks via a connection to San Luis Obispo in the U.S.

5.2 Pan American Cable Submarine Project

The Pan American Cable ("PAC") project is currently in the final stages of development. Construction on the PAC is scheduled to begin in 1996 and be completed in 1998. The system will become an integral part of the Latin American information superhighway by providing connectivity to the countries on South America's Pacific coast to various regional fiber optic cable systems. The PAC will land in Chile (Arica), Peru (Lurín), Ecuador (Punta Carnero), Colombia (Buenaventura and Barranquilla), Panama (Panama and Colón), Venezuela (Punto Fijo) and the United States (St. Croix/St. Thomas). The cable will extend approximately 7,300 kilometers and the system will use synchronous digital hierarchy (SDH) with two systems of 622 Mbps.[3]

The PAC system will eventually connect to an undersea fiber optic cable that Telmex proposes to construct. The Telmex Cable will connect the city of Colón in Panama to Cancun, México where it will connect with the Columbus II system.

5.3 Telmex's Central American Link

Telmex is currently planning to construct an undersea cable from Cancun to Colón, Panama with a spur to Puerto Cortes, Honduras. The cable would then interconnect with the terrestrial Central American fiber optic network proposed by the Regional Technical Central American Commission for Telecommunications ("COMTELCA"). The proposed undersea cable will provide connectivity between the Central American region and the Columbus II.

5.4 The Fiber Optic Link Around the Globe

The Fiber Optic Link Around the Globe ("FLAG") will be a 17,400 miles long system is scheduled to begin service on September 6, 1997. AT&T Submarine Systems Inc., and Kokusau Denshin Denwa Submarine Cable Systems are building the system, which has an estimated construction cost of US$1,200. FLAG will be linked to the PTAT-1 transatlantic cable, the North Pacific Cable, and to Teleglobe Inc.'s Cantat-3 cable. FLAG will operate as a carrier's carrier and has already sold capacity to approximately 46 international carriers.

6. Issues for Developing Countries to Consider with Regard to the Construction of Fiber Optic Cables

Following the lead of advanced competitive markets such as the U.S., most Latin American countries are working towards the development of a competitive telecommunications market to promote private investment in their respective telecommunications sectors. Consistent with the proliferation of cable systems in competitive markets, the developing countries must develop policies on certain key issues with regard to the construction of fiber optic cables within their national boundaries. This section will examine how the United States and several Latin American countries have addressed these considerations.

6.1 Licensing Requirements

In the United States, the basic authority required to build a domestic (or international) submarine cable with landing points within the United States is a Cable Landing License from the Federal Communications Commission ("FCC"). In addition to a cable landing license the cable operator must obtain authority under Section 214 of the Communications Act. Under section 214 of the Communications Act, common carrier cable operators are prohibited from unreasonable discrimination among customers. Common carrier cable operators must also file tariffs. A private cable is not subject to these common carrier obligations, and, a private cable operator would be able to individually negotiate deals with customers.

Other countries also impose similar forms of licensing requirements for the construction of a cable submarine systems. In the case of Mexico, for example, the construction, operation and exploitation of a cable submarine system requires a concession from the federal government to install, operate and exploit public telecommunications networks.[4] Public telecommunications networks and the services offered over them are considered to be public utility functions and are therefore regulated by the Secretariat of Communications and Transportation ("SCT").[5] The concessions granted by the SCT establish the terms under which such communication facilities may be exploited, the services that may be offered, and the rates that may be charged for the services. Infrastructure and facilities constructed pursuant to a concession will be the property of the concessionaires only for the period of time set forth in the concession, after which time, the facilities will revert to the State free of any charge, along with any corresponding rights of way, properties, stations, ports, etc.[6] Peru's telecommunications legislation also imposes specific licensing requirements for cable submarine systems.[7]

6.2 Environmental

Protection of the environment has been a growing concern for many countries during the last decade. Achieving the right balance between the need to develop national infrastructure and the desire to protect the environment has been an critical issue for many developing countries. Cable submarine systems and other telecommunication infrastructure projects have not been exempt of varying degrees of environmental regulation.

In the United States, the FCC also has authority to require an environmental impact statement or assessment in connection with the construction of a submarine cable landing station. Nonetheless, the FCC generally does not consider the laying of submarine cable to be a "major action," that would trigger a requirement to conduct an environmental impact statement under its rules. However, if the proposed cable construction does present issues of local environmental concern (for example, cable facilities proposed in Puerto Rico by AT&T involved crossing a coral reef in Puerto Rico's coastal zone), an environmental assessment must be supplied to the FCC as part of the application process, along with a certificate of compliance with relevant coastal zone plan.

Most Latin American countries also have enacted environmental legislation that require some form of environmental impact study for major infrastructure projects that may adversely impact the environment. By way of example, in Mexico, the General Law on Ecological Equilibrium and Environmental Protection (hereinafter the "Environmental Law") and the body of comprehensive rules and regulations[8] that regulate and protect the environment, provide that an environmental impact statement is required for projects involving bridges, ports, maritime viaducts, highways, airports, and gas and oil pipelines,[9] as well as for any other activities that may cause an ecological imbalance or exceed the limits and conditions set forth in the environmental regulations. Consequently, a submarine cable project would require the prior authorization of the federal environmental agency in Mexico.[10]

Likewise, in Colombia, the Law 99 of 1993 imposes a requirement for all infrastructure projects that may have an impact on the environment. In particular, the Law 99 requires parties to prepare and file an environmental impact statement with the Ministry of the Environment before the necessary environmental permits can be granted by the Ministry.

6.3 Rights-of-Way

Another important consideration for building and landing a cable submarine system is access to the necessary rights-of-way, particularly for systems that require partial land-based fiber builds for design reasons or in order to interconnect with other submarine systems. In the United States, providers of communications services have found that the regulatory scheme is often burdensome, time-consuming, and costly because the U.S. regulatory framework for rights-of-way mirrors the jurisdictional boundaries of the U.S. governmental structure (federal, state, and local). For example, while the federal government makes policy decisions regarding access to federally funded highways,[11] states control and mandate policies for use of state highways, bridges, and river crossings. Access to these rights-of-way generally requires the consent of the state agency charged with jurisdiction over the specific segment of right-of-way. Further, state enabling laws generally grant to counties, cities, towns, and other localities the power to control the use of local streets, alleys, highways, and other types of right-of-way. Therefore, a communications services provider must seek the consent of a local city council to obtain access to streets or other public right-of-way controlled by the municipality. Local standards for obtaining the required consents are far from uniform, and depend in large measure on the breadth of the authority granted to a municipality under the state enabling legislation. The process can, therefore, be time-consuming, expensive, and uncertain.

In Latin American countries, securing rights-of-way is less burdensome. For example, in Mexico, the SCT is responsible for granting federal rights of way over federal land, water and air space. Since rights of way are considered an integral part of general communications facilities, the rights of way required for the construction and operation of the services concessioned are also authorized by the SCT when a concession is awarded. Private rights of way would have to be negotiated directly with the property owners. However, if the concession holder and the other private owner cannot reach an agreement over the right of way, the SCT will play the role of mediator.

6.4 Other considerations

Many countries, including the United States, have enacted legislation restricting the level of foreign investment in certain areas of the economy. Telecommunications has historically been a sector where foreign ownership has been restricted because of national security concerns. Notwithstanding, today most countries allow some forms of foreign participation in their telecommunications sectors. Mexico, for example, allows 100% foreign ownership of companies that provide value-added services. In the case of basic telephony, however, foreign investors cannot own more than 49% of the voting capital of a company that has a concession for a public telecommunications network. Peru, on the other hand, does not have any foreign ownership restrictions.

Another important consideration for developing countries is the need to train the domestic workforce of each country. While the foreign investment restrictions usually address this concern by ensuring certain degree of domestic ownership and management of the telecommunications companies, many countries have also adopted specific requirements regarding the level of training that domestic workers must receive.

7. Conclusion

As the discussion above demonstrates, the inherent characteristics of submarine fiber optic cable systems are well-suited to meet the regional and global connectivity needs of developing countries in Latin America as well as their respective national telecommunication infrastructure upgrades. Among other benefits, submarine fiber optic cable systems provide high capacity and reliability with relatively nominal investments compared to the costs of upgrading existing terrestrial systems. Following the lead of Argentina, Chile, Mexico, and Peru, other Latin American countries will undoubtedly liberalize and aggressively pursue telecommunications infrastructure upgrades. As a result of the ensuing competitive environment, Latin American countries on this course will be required to develop policies with regard to environmental and licensing issues as well as other policies that will faster competition in the telecommunications sector.

1. Fiber optics is a technology in which light is used to transport information from one point to another. Specifically, fiber optics are thin filaments of glass through which light beams are transmitted over long distances carrying enormous amounts of data. Modulating light on thin strands of glass produces major benefits in high bandwidth, relatively low cost, low power consumption, small space needs, total insensitivity to electromagnetic interference or monitoring devices.

2. The region as a whole averages 8% line penetration compared to a 52% penetration in the United States and Canada and 56% in Europe. Latin Finance, September 1995 Supplement.

3. Participants in the project are divided into three categories: (i) Initial Parties; (ii) Terminal Parties; and (iii) Additional Parties. The Initial Parties are those companies that subscribed the Memorandum of Understanding to conduct the feasibility and engineering studies for the project. The Initial Parties are comprised primarily of Latin American telephone companies including: Entel Chile; Telintar de Argentina; Entel de Bolivia; Telefónica del Perú; Emetel de Ecuador; Telecom de Colombia; CANTV de Venezuela; Intel de Panama; ICE de Costa Rica; ANTEL de El Salvador; ANTEL de Nicaragua; Telcor de Nicaragua; Telmex de México; Telefónica de España; Transoceanic Communications from the USA; and AT&T from the USA.

4. The Law of General Means of Communications (hereinafter "Communications Act") and the Federal Telecommunications Law (hereinafter "FTL") govern all federal means of communication in Mexico, including telecommunications and all forms of communications by land, sea, and air. General means of communications include (i) territorial waters; (ii) air space; (iii) telephone lines installed within 100 kilometers from the border or 50 kilometers from the coastline, as well as telephone lines situated within the limits of a state if such lines connect to the telephone lines in another state or to the telephone lines of another country, or when such telephone lines are auxiliary to other general means of communications; and (iv) electromagnetic waives. General Communications Act at Article 1.

5. The Secretariat of Communications and Transportation is the federal department responsible for regulating the telecommunications sector.

6. Communications Act at Article 89.

7. By way of background, the recently enacted Telecommunications Law classifies telecommunications services into four categories: (i) carrier services; (ii) final services; (iii) broadcasting services; and (iv) values-added services. Carrier services are defined as those telecommunications services that provide the capacity necessary to transport signals that allow the provision of final, broadcasting or value-added services. Carrier services may be provided by state-owned or private companies pursuant to a concession granted by the Ministry of Transportation and Communications. The installation and operation of a cable submarine system falls under the category of carrier service, and therefore, requires a concession from the government.

8. Regulations for the Prevention and Control of Water Pollution; Regulations on the General Law on Ecological Balance and Protection of the Environment regarding Environmental Impact; Regulations on the General Law on Ecological Balance and Protection of the Environment regarding Prevention and Control of Atmospheric Pollution; Regulations on the General Law on Ecological Balance and Protection of the Environment regarding Hazardous Waste; Regulations for the Protection of the Environment Against Pollution Originated by Noise.

9. Regulations on the General Law on Ecological Balance and Protection of the Environment regarding Environmental Impact at Article 5 (III).

10. SEMARNAP is the department in the Mexican Government responsible for implementing the Environmental Law.

11. The federal policy, however, is implemented primarily through state agencies; each state has its own department of transportation or an equivalent agency that has a special department devoted to the administration of federal highways.

INSTALLATION AND BURIAL OF A 240 KILOMETER LONG "ASN 14mm" FIBER OPTIC TELECOMMUNICATION CABLE IN BASS STRAIT USING THE "SHIP-OF-OPPORTUNITY" INSTALLATION TECHNIQUE

Michael R. Harrison
Science Applications International Corporation, MariPro Operations
1522 Cook Place
Goleta, CA 93117 USA

Brett Worrall
Alcatel Submarine Networks (Asia Pacific Region)
96 Sommerset Road, #04-01 UOL Building
Singapore 238963

1. ABSTRACT

SAIC/MariPro was contracted by Alcatel TCC, Sydney Australia, to install a 240 kilometer long submarine fiber optic cable system across Bass Strait in June, July, and August 1995. This eighteen-fiber cable system will provide telecommunication services between mainland Australia and Tasmania for customers of TELSTRA (formerly Telecom Australia). The submarine cable system was successfully deployed and buried to an average depth of 1.0 meters along the proposed cable route as shown in Figure 1.

2. INTRODUCTION

As a result of over 30 years of diversified cable installation experience, SAIC/MariPro has pioneered the "Ship-of-Opportunity" concept to significantly reduce the installed cost of submarine cable systems.

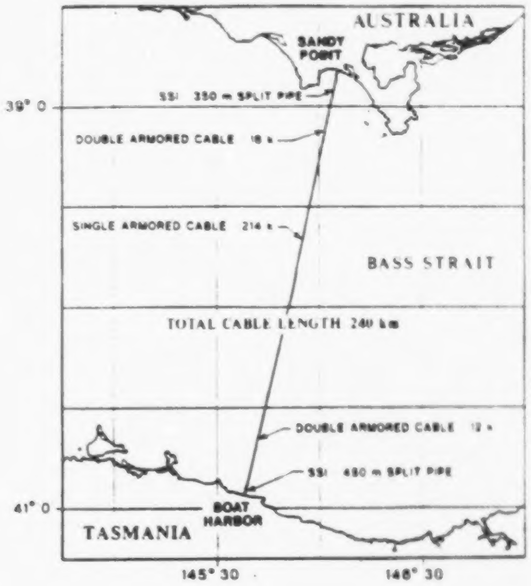

AUSTRALIA
SANDY POINT
SSI 350 m SPLIT PIPE
39° 0
DOUBLE ARMORED CABLE 18 k
SINGLE ARMORED CABLE 214 k
BASS STRAIT
TOTAL CABLE LENGTH 240 km
DOUBLE ARMORED CABLE 12 k
SSI 480 m SPLIT PIPE
41° 0
BOAT HARBOR
TASMANIA
145° 30
148° 30

Figure 1
Bass Strait 1 - Cable Route

Figure 2
M/V FAR SUPPLIER Mobilized for Installation

The core of this approach is the use of containerized linear cable engines integrated with the necessary deployment chutes, cable pans and navigation and control systems. This installation equipment is shipped to the nearest "ship-of-opportunity" port facility for mobilization. Once mobilized, the vessel performs the necessary cable installation tasks. Upon completion, the vessel returns to the local port, the equipment is removed, and the vessel is taken off charter. Equipment is then repaired/maintained as necessary and shipped to the next installation location.

Purpose-built cable ships are the appropriate technical choice for long trans-oceanic telecommunication cable system installations. However, past experience has shown that for relatively short, individual submarine cable installation operations (less than 300 kilometers), the "ship-of-opportunity" method is less costly, more flexible, and not constrained by higher priorities. For the Bass Strait-1 (BS-1) program, a single vessel was used to conduct the route clearing operation, to lay and bury all of the fiber optic submarine cable including the sea shore interface (SSI) cable systems at both ends, and to conduct the post lay inspection and burial (PLIB) operation. The cable installation vessel chosen for the BS-1 installation was the M/V FAR SUPPLIER, operated by Australian Offshore Services (AOS), Melbourne, Victoria. The cable deployment and burial equipment, which amounted to approximately 225 Tonnes of equipment (not including cable), was mobilized onto the vessel within a 5 day period, at a Mobilization and Staging Area (MASA) near Melbourne (See Figure 2).

The MASA was located at the Port of Geelong, approximately 100 kilometers southwest of Melbourne and approximately 200 kilometers from the BS-1 Australia shore landing site. Following the mobilization phase, the vessel transited to Alcatel TCC's cable factory in Port Botany, NSW (near Sydney) to load the main cable plant (Figure 3).

The cable deployment and burial operation began at Sandy Point, Victoria on 27 June. The installation proceeded across Bass Strait, was interrupted by several weather delays, and arrived at Boat Harbour, Tasmania on 28 July. Deployment speed varied between ¼ and 2¼ knots throughout the cross-strait cable lay, and averaged approximately 1½ knots. The cable burial depth exceeded 1.0 meter for 95% of the route. The cable plough tow wire length and tension was adjusted to accommodate the changes in seafloor conditions. Video cameras and sonar equipment on-board the plough body were used to monitor the area ahead of the plough for obstructions as well as to ensure correct telecom cable tension and burial depth. Although very few in number, obstacles were avoided by moderate course changes of the installation vessel.

The scope of work for the BS-1 cable installation, included the following tasks and operations:

- Planning (including marine operating permits)
- Vessel and equipment specification and selection
- Mobilization and demobilization
- Cable route clearance operation
- Cable loading
- Cable plough burial test
- Cable lay and burial including shore landings
- Post Lay Inspection and Burial (PLIB)
- Discharge of spare cable
- Subsequent reporting for the installation.

3. RATIONALE FOR SHIP-OF-OPPORTUNITY

The volume and weight of the BS-1 system cable was such that a typical dedicated cable vessel would have a capacity far in excess of what is required to efficiently perform this system installation. These larger cable ships require large crews, more fuel, and incur overall greater costs. Also, these vessels are

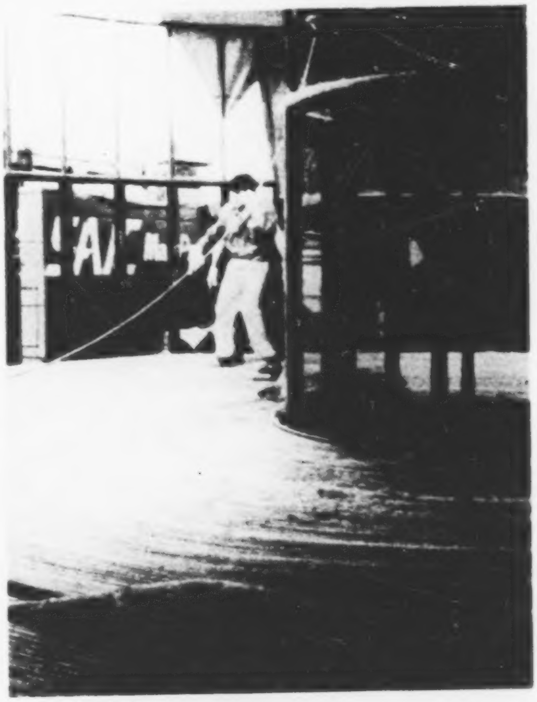


Figure 3
Cable Loading Aboard Ship
(Note joint in foreground)

typically committed years in advance for long distance cable installations and maintenance, often lasting several months. Relatively short installation charter durations, such as for the BS-1 installation, (less than three months), make it very difficult to secure a dedicated cable ship to meet specific cost and schedule goals. SAIC/MariPro has developed a modular, deck-mounted spread of cable installation equipment that can be rapidly and efficiently fitted to any vessel that meets the requirements of maneuverability, deck area/capacity, cost and availability. Vessels meeting the specifications are examined and rated based upon performance, as well as mobilization and operating costs. The competitive nature of this selection process ensures that a suitable installation vessel can be chartered at the lowest possible overall cost.

4. MINI-TUBE 14mm DIAMETER CABLE

The cable type selected by Alcatel Submarine Networks (ASN) for BS-1 had to facilitate the ship-of-opportunity approach. This requires a lightweight, low volume cable design that could be handled and plough buried in the marine environment of Bass Strait.

The cable selected to be installed across Bass Strait was the 14mm version of the Alcatel Submarine Networks (ASN) "mini-tube" repeaterless cable. This cable is specifically designed for repeaterless links where low cost and high fibre counts are the major design factors. The cable possesses a minimum 25-year life cycle. A cross section of the lightweight (LW) 14mm diameter cable is shown in Figure 4.

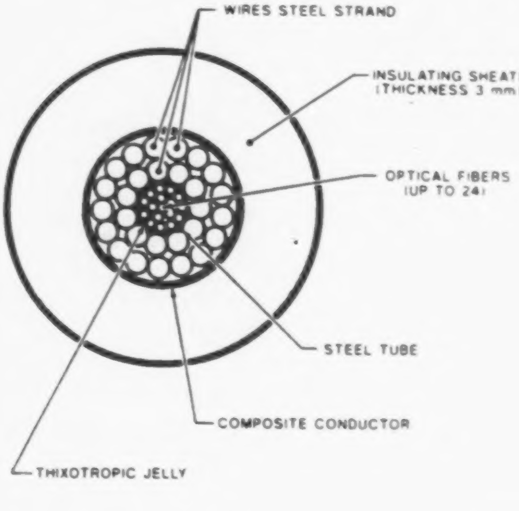

WIRES STEEL STRAND
INSULATING SHEATH (THICKNESS 3 mm)
OPTICAL FIBERS (UP TO 24)
STEEL TUBE
COMPOSITE CONDUCTOR
THIXOTROPIC JELLY

Figure 4
ASN 14mm LW Mini-Tube Cable

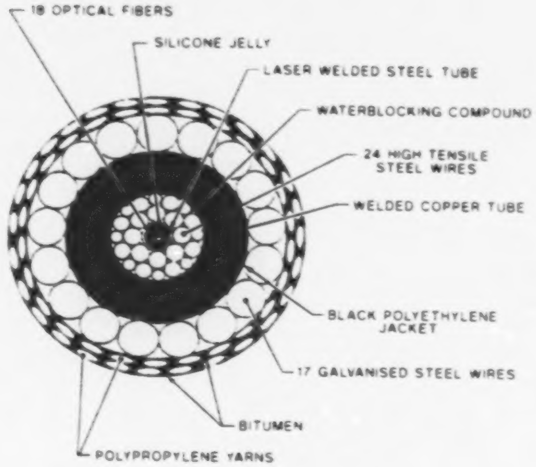

18 OPTICAL FIBERS
SILICONE JELLY
LASER WELDED STEEL TUBE
WATERBLOCKING COMPOUND
24 HIGH TENSILE STEEL WIRES
WELDED COPPER TUBE
BLACK POLYETHYLENE JACKET
17 GALVANISED STEEL WIRES
BITUMEN
POLYPROPYLENE YARNS

Figure 5
ASN 14mm SA Mini-Tube Cable

Following the findings of the route survey report, the cable configuration for the BS-1 application included both single armor (SA) and double armor (DA) cable, where the DA cable was used for the inshore regions. Figures 5 and 6 present cross-sections of the SA and DA cable, and Table 1 presents a summary of the cable specifications. In addition, the cable was required to be buried along the entire route to further protect it from possible external aggression.

Table 1
ASN 14 mm Mini-Tube Cable Summary Specifications

	LW	LWP	SA	DA
Overall Diameter	14	19.6	27.2	36.8
Breaking Load (kN)	60	60	186	264
Weight in Water (kN/km)	2.8	3.1	10	24
Acceptable Residual Tension (kN)	12	12	58	50

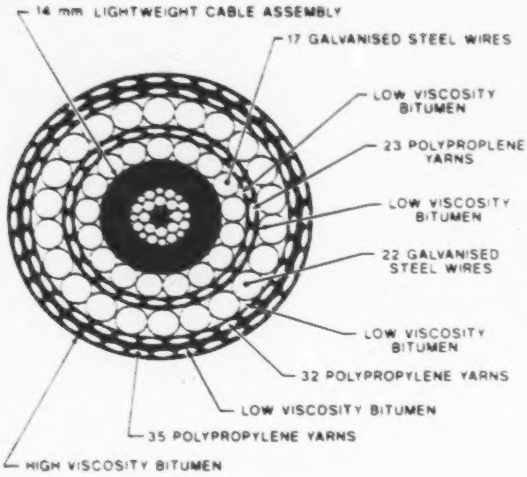


Figure 6
ASN 14mm DA Mini-Tube Cable

The cable manufacturing process was shared between Alcatel's facilities in France and Australia, with the majority being conducted at the Port Botany facility in Australia.

The customer requirement for the BS-1 program specified that extremely low attenuation, and chromatic dispersion values were mandatory for the manufactured cable. The ASN "mini-tube" design caters to both of these requirements. Pure silica core optical fibre was used in the BS-1 cable. This type of fibre exhibits the lowest theoretical attenuation for submarine qualified fibre and ensures the customer's attenuation requirements are met.

The stringent requirements for chromatic dispersion necessitated the specific "matching" of fibre sections within the cable to ensure the "end to end" dispersion specification was respected.

The principle characteristics of the 14 mm cable ensures that for each application the necessary properties of the cable can be adapted. Hence, different protection structures can be provided around the LW (lightweight cable) product as illustrated in Figures 5 and 6.

In addition, the fibers have a defined excess length relative to the tube, which is filled with a thixotropic, non-hygroscopic and water-blocking compound. The cable design ensures that no strain, and ultra low pressure is exerted on the fibre during normal operation.

5. OPERATION LOCATION

5.1 BATHYMETRY

The profile of the BS-1 route is generally a flat-bottomed channel composed predominantly of calcareous mud. The sea bottom slopes gently away from Sandy Point to a maximum water depth of 80 meters. The bottom is mostly flat and featureless until approximately 35 kilometers offshore from Boat Harbour, at a water depth of 60 meters. There, the sea bottom ascends to a depth of 30 meters approximately 2 kilometers offshore and then increases at a medium gradient to Boat Harbour.

5.2 LANDING POINTS

Sandy Point is a broad, gently sloping beach that forms part of Warratah Bay. It is well covered with sand, with only one known reef or shoal located 2 kilometers offshore. It is directly exposed to southerly winds which were evident during the installation operation. The water depth 2 kilometers offshore is approximately 20 meters. An environmentally sensitive barrier dune system running the length of the bay is located directly behind the beach.

Boat Harbour has a small beach area and is well protected from incident winds and seas from the south and west. Extensive rock outcroppings are located throughout the area. The cable landing area is located at a popular beach resort with small craft anchoring in the lee of the adjacent Shelter Point.

5.3 WEATHER CONSIDERATIONS

The BS-1 system was scheduled to be on line late in 1995. To meet this schedule it was required that the installation take place from May to August 1995 in the midst of the region's worst weather patterns. During this time of year, the region is subjected to the strong westerly winds known as "The Roaring Forties". Severe storms occur frequently with gale force winds reaching 8 and above.

Weather is always a consideration in the deployment of submarine cable. In the Bass Strait, severe weather systems can develop quickly, to a point where cable deployment and ploughing operations should be suspended or delayed due to hazard to the cable, equipment and personnel. Accurate and frequent weather forecasts are imperative immediately prior to and during the cable lay.

For the BS-1 installation program, two independent weather forecast services were employed to provide two forecasts per day. The forecasts enabled the installation management team comprised of the vessel master, the SAIC/MariPro installation manager, the TELSTRA representative and the Alcatel TCC operation manager to develop a daily strategy and plan future events. The two forecasts generally agreed, were relatively accurate, and were invaluable to the operation.

5.4 OCEANOGRAPHIC CONDITIONS

Tidal currents along the cable route area were generally 0.1 meters/sec (0.19 knots). Surface currents caused by turbulent wave action were on the order of 1 meter/sec (1.9 knots) and under extreme conditions greater than 3 meters/sec (5.9 knots). Seawater temperature was approximately 13° C or 56° F.

Sandy Point has a median significant wave height of about 2.0 meters with maximum significant wave height of approximately 3.6 meters. Storm conditions can produce significant wave heights up to 10 meters with maximum wave heights of 18 to 20 meters during extreme conditions.

In central Bass Strait the significant wave height is approximately 2.0 meters, but can increase up to 8 to 15 meters with a severe southwesterly storm.

Boat Harbour provides shelter from the prevailing south and westerly winds with a median wave height of 0.5 meters. Storms typically create seas with a significant height of 1.0 to 1.5 meters.

Maximum tide fluctuations were between 2 to 3 meters during the installation operation.

6. INSTALLATION APPROACH

6.1 CABLE BURIAL METHOD

The survey data available for the BS-1 cable route indicated that the seafloor has benign topography and consists almost entirely of soft mud and sand. Although some harder sediment regions were encountered near the shore ends, the soft sediments dominated the course route. In addition, there were no major course changes over the entire section to be buried. These bottom characteristics made it ideal for towed plough burial of the system cable (Figure 7). Self-propelled vehicles (tracked or wheeled) have a tendency to get easily mired in soft bottom conditions like those that exist over the majority of the BS-1 cable route. Water jetting ROV's that bury cable have burial rates well below that of a towed plough.

Risk of cable damage is mitigated by utilizing experienced personnel and equipping them with state-of-the-art deployment tools. SAIC/MariPro's advanced, computer aided deployment and navigation system (CADNAV) allows for monitoring of all major equipment and deployment activities. This provides installation personnel with real-time data to make critical deployment decisions.

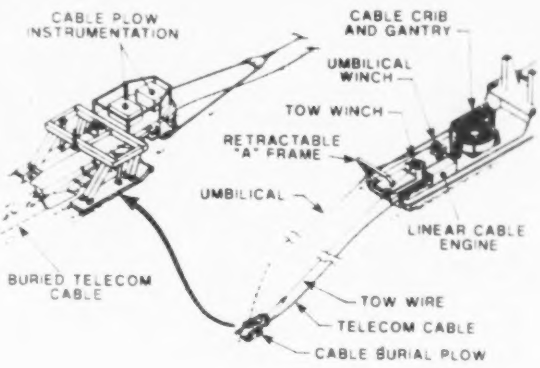


Figure 7
Typical Cable Burial Operations

Oceaneering Technologies (OTECH) of Annapolis, Maryland were selected to provide the cable plough system (Figure 8). The "Sea Dragon" cable plough was designed by KDD of Japan, and manufactured by Applied Automation in Singapore. OTECH made several major modifications to the design including the addition of hydraulically controlled stabilizer skids and cable depressor. An elaborate electronic monitoring and control system comprised of a pitch and roll sensor, a forward looking sonar, a cable burial depth sensor and an altimeter were included in the improvements.

6.2 BEACH LANDING METHOD

Conventional (long-haul) cable installations use a beach landing method in which the shore landing cables are pre-installed and buoyed off at some distance offshore. The main cable span deployment starts with an at-sea joint at one end, followed by the lay to the opposite shore, and finishes with an at-sea joint at the far shore. At-sea joints of optical cable can be time-consuming and add additional risk of cable damage due to potential vessel motions during splicing operations.

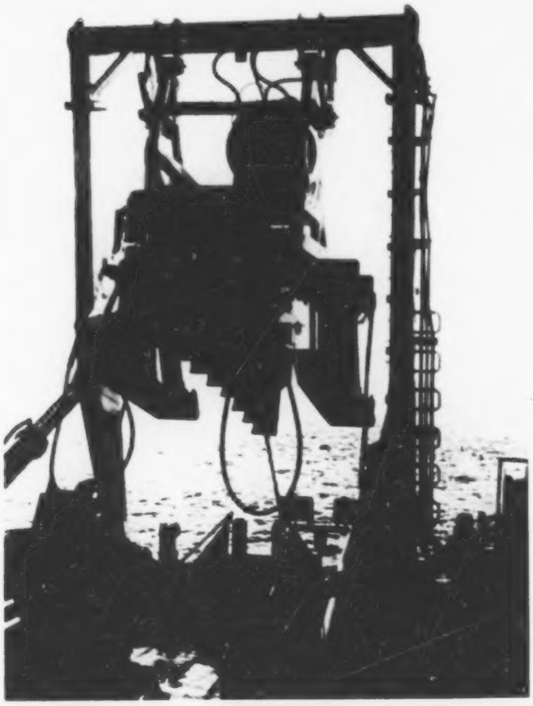


Figure 8
"Sea Dragon" Cable Plough

A "no at-sea joint" technical approach was adopted for the BS-1 system cable beach landings. This technique started by floating the Sandy Point cable end ashore with articulated pipe installed. After the cable end was terminated at the beach termination manhole, cable deployment (and burial) proceeded to the next beach landing site. At Boat Harbour the cable was floated out in a bight near shore and trimmed to the exact length. The end was then pulled to the shore manhole for termination.

6.3 CABLE LAY INSTALLATION DIRECTION (SANDY POINT TO BOAT HARBOUR)

A careful review of the desktop study and route survey report prepared for the BS-1 system cable revealed that the predominant weather (wind and swell) for the scheduled installation period was from the south and west. Given this information, an installation approach beginning at Sandy Point and ending at Boat Harbour places the vessel on a heading of approximately South-Southwest for almost the entire cable lay.

Heading into the weather allows for improved ship heading and course control as well as providing increased protection for the cable machinery on the after deck. In addition, storm surf conditions are generally much worse at the Sandy Point landing site when compared to Boat Harbour. By starting at Sandy Point, cable landing operations could be delayed until the surf conditions are suitable. Boat Harbour is better protected from the predominant southerly and westerly weather, therefore the time of the beach landing operation was not as critical.

In summary, a north to south direction of lay was selected to provide minimum potential exposure to weather hazards and provide maximum control for the installation vessel.

6.4 MOBILIZATION AND STAGING AREA (MASA)

To support the mobilization and demobilization of the vessel for the various operations a MASA facility was established in Geelong Victoria, where crane, dock and other required services were available. The MASA included a large, paved open space and a large covered warehouse capable of handling, staging, pre-assembling, and checking out of the installation equipment. The MASA also provided sufficient dock space where the installation vessel was mobilized. Equipment not in use during different stages of the installation was stored at the MASA. Demobilization and packing of equipment for return shipment also took place at the MASA facility.

Geelong is an business center and home to many large and small industrial corporations including Ford Australia. Geelong provided a large and diverse industrial base to support the operation including steel and metal fabrication, large crane support, and miscellaneous industrial supplies. SAVA Engineering was selected to provide manufacturing and welding services and Barry James Crane for all lifting services. The Port of Geelong and the Victorian Regional Stevedores provided port services and forklift support. The support received from all of the local subcontractors was critical to minimizing the time required to mobilize and demobilize the installation vessel, and for the eventual success of the

1038

program.

7. CABLE ROUTE CLEARANCE OPERATIONS

Cable route clearance operations were performed prior to BS-1 cable system installation operations. The installation vessel towed a specially designed 1.0 meter deep grapnel along the track of the proposed cable route. Figure 9 shows the grapnel being deployed. The grappling operation prepared a clear path for the cable plough along the planned cable route.

Figure 9
Route Clearance Grapnel

The removal of any potential abandoned cables located along the cable route was of primary concern to the operation . Up to six abandoned cables were thought to be along the route, but only three were tentatively identified in the TELSTRA survey report. The grapnel encountered no debris along the entire route including along two of the abandoned cable sites, but the third cable site, located almost 26 kilometers from the Tasmania end, revealed an unknown obstruction at a burial depth slightly below 1.0 meter. The obstruction was subsequently identified during the PLIB operation as a 10 meter wide, smooth rock shelf located 100 mm below the surface.

In addition to the primary task of cable clearance, this operation was used to simulate ploughing operations allowing for the pre-installation training for vessel operators and navigation personnel over the entire route to be ploughed. Cable deployment was simulated with real-time navigational inputs on the display monitors.

In summary, the cable route was run within a track accuracy of ± 50 meters over a majority of the cable installation route. The grapnel depth was up to 1.2 meters deep. The first 100 kilometers beginning at Sandy Point appeared to be harder soil than the remaining portion. Only at a few locations did the grapnel appear to experience any conditions other than sandy mud during the final 139 kilometers.

In the areas of the noted old cable locations, all the cables, if in existence, lay below the one meter plough depth or are deteriorated to the point that they break easily and were unrecoverable.

8. INSTALLATION OPERATION SEA TRIAL

The SEA DRAGON is a modified KDD plough with little history of past work experience. The plough system was successfully tested in Galveston, Texas in February 1995. Additional testing and demonstration was carried out in Australia prior to the installation operation. The objectives of the sea trials included:

- Verifying operational procedures for cable insertion into the plough, initial positioning on bottom, normal plough operations, and plough/cable launch and retrieval
- Demonstrating burial of length of telecommunications cable to a depth of not less than 0.6 meters without physical, optical or electrical damage
- Verifying plough stability as a function of plough speed, terrain slope, burial depths and horizontal and vertical tow angle
- Measuring of tow tension and tow angle
- Verifying general (sub)system functions, including sensor performance, control of hydraulic functions, data display and logging, and electrical current measurements
- Verifying plough performance in a horizontal turn similar to that planned for the BS-1 operation
- Verifying the ability to pass a cable joint.

9. SEA SHORE INTERFACE OPERATIONS

9.1 CABLE SHORE LANDINGS

The SSI cable at Sandy Point and Boat Harbour was comprised of double armor cable measuring 35.3 mm in diameter, and protected by 300 meters and 450 meters, respectively of cast iron articulated split pipe. The split pipe was installed to provide additional protection in the shallow water regions most susceptible to beach erosion and third party damage. The shore landing operation at Sandy Point is shown in Figure 10. The cable and pipe were later buried to 2.0 meters depth on the beach by a tractor, and to 0.6 meters depth in the water by divers using hand jetting and airlift tools. The sea shore interface cable at Sandy Point was installed on 28 June 1995. Beach preparations at Sandy Point began several days beforehand with the installation of two deadman anchors, and the digging of the cable trench. The manhole was located on the far side of a beach berm approximately 170 meters from the low water mark. A 100 mm diameter PVC duct was installed under the berm. A backhoe was used to position a turning block near the duct. A D6 tractor was used to pull the cable ashore.

The vessel was approximately 800 meters offshore using a single bow anchor and the integrated joystick control to maintain position within ± 10 meters. A pulling line was paid out from the vessel to the beach using a small boat. On the beach, the end of the pulling line was threaded through the turning block and secured to the beach tractor.

Figure 10
Sandy Point Sea Shore Interface (SSI)
Split Pipe Installation

The SSI cable was installed by simultaneously pulling the cable on the beach with the tractor, and paying the cable out on the vessel. The cable tension was limited to under 14 kN (3 Kips), and a payout speed less than 30 meters/min (100 fpm). Inflatable pillow floats were lashed to the cable before it exited overboard. When approximately 170 meters of cable was deployed, sections of interlocking articulated split pipe were installed on the cable. Inflatable floats were also used to float the split pipe to the beach.

Deteriorating weather conditions, characterized by 25 knot cross-winds and 2.0 to 3.0 meter seas caused the floating cable to bow slightly towards the east.

The beach crew continued to pull the cable up onto the beach until the articulated pipe sections were near the PVC conduit leading under the berm. The end of the cable was then fastened to a pulling line inside the PVC conduit, and the cable was pulled through the conduit by a small tractor located on the far side of the berm next to the beach vault.

9.2 ARTICULATED SPLIT PIPE

The articulated pipe is an Alcatel TCC patented design which is shown at Figure 11. The design allows the simultaneous laying and installation of the articulated pipe during normal shore end operations. This capability is possible due to the tool free installation method used for applying the pipe to the cable. This method is depicted in Figure 10 above and Figure 12.

The installation process requires no bolts or screws, instead it relies on an interlocking hook arrangement from each set of adjacent pipe sections. The material used to manufacture the articulated pipe is "spherulitic graphilitic iron" (SGI), or more commonly known as nodular or ductile iron. The additional strength and toughness of SGI over cast iron is required to withstand the stresses which develop in the interlocking joint. Additionally, the pipe allows for the installation over the stern of the installation vessel with reduced bend radii, and supports the catenary for laying and recovery at greater depths than with conventional pipe.

9.3 CABLE TESTING AND TERMINATION

With the cable in its final position it was tested at the beach vault to ensure that it was not damaged during the beach landing operation. Upon completion of fiber testing, divers released the floats from the cable allowing it to settle to the ocean floor.

Alcatel TCC was responsible for supplying the testing and monitoring equipment, and performing the cable jointing operations. The testing and termination of the cable began as soon as the cable end was available at the beach vault. The cable was tested using an OTDR, and for insulation resistance. The cable deployment burial operation was not begun until the end of the cable was terminated to the land duct cable and the monitoring equipment. This procedure was accomplished in less than two hours.

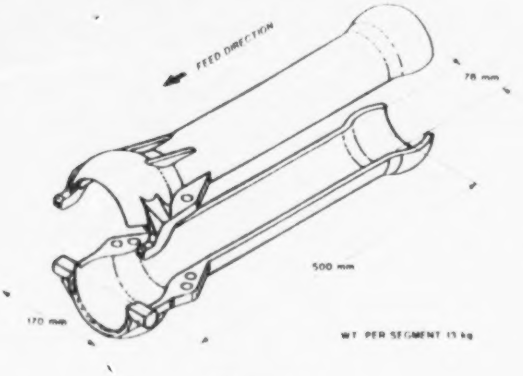


Figure 11
ASN Articulated Split Pipe

10. SUBMARINE CABLE INSTALLATION AND BURIAL OPERATIONS

10.1 VESSEL OPERATION

The minimum required burial depth for the system cable was 0.6 meter, however the target depth for the operation was 1.0 meter. This was achieved on all but approximately 12 kilometers of cable, or only 5% of the total 240 kilometers length. Up to 8 kilometers was buried to a minimum of 0.6 meters. Only 4 kilometers (less than 2%) of the cable was not buried by the plough to the minimum depth required. This amount of cable was buried during the PLIB operation which followed immediately after the installation operation.

Ten factory joints were contained in the system over the 240 kilometers length. The BS-1 system cable was intended to be installed in one continuous length without the necessity of performing an at-sea joint.

Unfortunately, the weather at Sandy Point continued to deteriorate to 2.5 to 3.5 meter seas, and 30 to 35 knot winds, following the beach landing. After a 24 hour period in which the vessel held station 2 kilometers off the beach with the telephone cable being tended over the stern chute, the decision was made to "cut-and-run" and lay the cable on the bottom. The FAR SUPPLIER returned to port in Geelong to wait out the first weather delay of the program, which lasted 7 1/2 days.

The vessel returned to the site on 6 July to rejoin the end of the cable and resume installation operations. The cable jointing operation for the 18 fiber double armored cable required 30 hours to complete. To minimize post burial, 800 meters of cable was recovered back off the bottom before resuming ploughing operations.

The cable deployment/burial operation resumed on 7 July following the jointing of the cable. Ploughing speed was reduced to an average of 0.5 knots and burial depth to 0.7 meters for much of the time over this section of cable because of the stiffness of the bottom material. Seventy kilometers of cable was deployed and buried before experiencing the second weather delay on 10 July.

The weather had deteriorated to Sea State 4 (25 to 35 knot winds, 2.0 to 3.0 meter seas), but forecasts suggested that the weather had peaked and would eventually moderate. Because the operation was proceeding well under these deteriorated conditions, the decision was made early on 10 July to continue instead of recovering the plough. The cable engine was properly compensating for the pitch and roll of the vessel, deploying the cable at a relatively constant tension, and the cable was passing through the plough at a relatively constant burial speed of 1.5 knots.

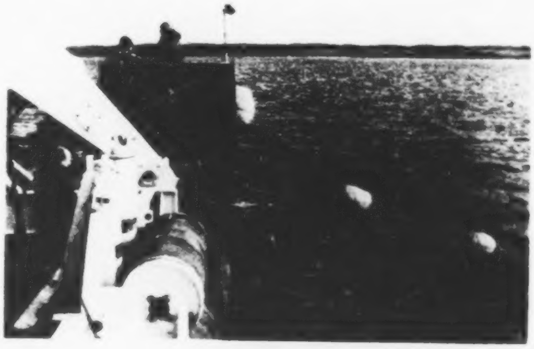


Figure 12
Cable and Articulated Pipe Being Floated Ashore

However by 1600, the weather had deteriorated further to Sea State 5 conditions, and the decision was made to "cut-and-run". Because it was judged to be unsafe to recover the plough, the plough tow and umbilical cables were cut and left on the bottom. In order to avoid having to re-terminate or rejoin the tow cable, almost all of it was paid out from the tow winch before cutting.

Two days later, the cable plough was successfully recovered during a short 18-hour weather window. A grapnel was used to recover the cables one at a time. The CADNAV navigation system was used to accurately note the positions of the cables, and to direct the grapnel operation to avoid damaging cables.

The vessel returned to the site on 20 July and stood by until the weather improved enough to recover the cable and buoy it off on the surface. The weather improved enough on 23 July to rejoin the telecom cable. Unfortunately, once the jointing process was completed, the weather had again deteriorated and the vessel was forced to hold station for an additional 24 hours with the cable tended over the stern chute.

The weather finally improved enough to resume installation operations on 25 July. Conditions remained excellent for the next three days as the deployment/burial speed averaged 1.5 knots and burial depth averaged 1.0 meters. Because the survey report indicated that the remaining region was intermittently covered by large rock outcrops and areas of coarse sediment, the plough was recovered approximately 4.7 kilometers from Boat Harbour. The cable was surface laid the remainder of the way to within 700 meters of the beach.

10.2 SEA SHORE INTERFACE OPERATION AT BOAT HARBOUR

Preparations for the cable shore landing at Boat Harbour had again begun several days in advance of the vessel's arrival. A two meter deep trench had been excavated between the low water mark and the beach manhole. An excavator was used to position the turning block high above the beach surface, and a backhoe was positioned on the beach to pull the cable ashore. The beach at Boat Harbour was not large, therefore the backhoe needed to take several "bites" of the pulling line to get all the cable ashore.

When the divers had completed their survey of the cable, a small boat was used to transfer the end of the pulling line from the installation vessel to the beach. The Boat Harbour pulling operation differed from the Sandy Point beach landing because the cable was floated to shore without split pipe. The distance between the stern of the vessel and the beach manhole was accurately measured to determine the exact location at which to cut the remaining cable. This amount totaled 1,000 meters.

It was also necessary to "float out" the large 1,000 meter long bight of cable on the water surface in order to access the end, apply a water block cap, then fasten the end to the pulling line. Four small boats were used to tend the cable as it was paid out over the stern while floats were attached.

The vessel continued to maintain station while holding the seaward portion of the cable until the entire bight was "pulled out", and the cable was straight to the beach. Divers then proceeded to cut away the floats beginning at the seaward end. Articulated split pipe was installed on the cable by divers several days later (Figure 13) and jetted into a depth of 0.6 meters.

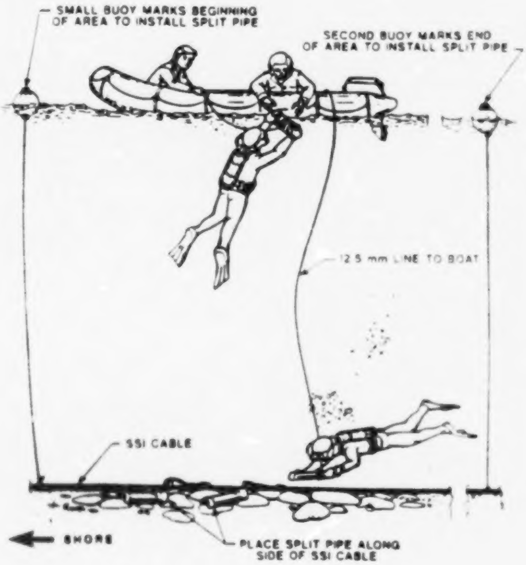

SMALL BUOY MARKS BEGINNING OF AREA TO INSTALL SPLIT PIPE
SECOND BUOY MARKS END OF AREA TO INSTALL SPLIT PIPE
12.5 mm LINE TO BOAT
SSI CABLE
SHORE
PLACE SPLIT PIPE ALONG SIDE OF SSI CABLE

Figure 13
Divers Install Articulated Pipe on Cable

10.3 TELEPHONE CABLE TENSION MONITORING

The stern chute was equipped with a load cell device to measure cable tension over the stern. A signal feedback loop to the LCE allowed the operator to select a desired cable tension on the surface. Once selected, the LCE paid out the cable at a relatively constant tension by varying payout speed to compensate for the vessel's forward speed, and the vessel's pitch and roll motion. The system worked flawlessly throughout the entire operation.

To minimize the residual tension in the cable after it was installed and buried, it was necessary to minimize the tension at the stern chute. In periods of moderate to high vessel motions, the average cable render tension was increased so that the minimum cable tension never approached zero tension on the bottom at the plough.

The plough operator also visually monitored the cable tension entering the plough through the plough's forward looking video camera. The cable tension was adjusted according to the touchdown point of the cable in front of the plough. Because the visibility was excellent throughout the majority of the operation, this provided the best indication of required cable tension. The telephone cable tension was increased for only very short periods of time, to straighten the cable on the bottom, or to lift it over small obstructions, but generally the tension was maintained between 200kg and 500kg.

11. POST LAY INSPECTION AND BURIAL (PLIB)

Following the successful deployment of the BS-1 system cable, 23 locations were identified as requiring PLIB inspection and/or burial. The 23 locations amounted to 17.282 kilometers or 7.2% of the total length of the system. Oceaneering's Magellan 160 cable burial ROV and Innovatum cable tracking system was used to conduct the PLIB operation.

The portions of the cable lay that were inspected and/or buried after installation are identified below:

- Unburied cable between the end of the articulated pipe and where the cable was buried by the plough at both beach landings
- Cable joints and any portions of cable left unburied during the cross strait cable lay
- Areas to be inspected or re-buried as identified by the on-site customer representative

The position fixes identified during the cable installation were used to navigate the vessel to the areas to be inspected and/or buried.

To conduct the survey, Alcatel TCC provided a low frequency 25 Hz tone at approximately 160 mV peak to peak (160 milliamperes) transmitted along the cable armor wire. During PLIB operations the vessel maintained station over the area to be inspected/buried while the ROV was deployed to perform the specified task. CADNAV navigation and documentation systems used during the cable installation remained in place for the PLIB operations.

12. COMPUTER AIDED DEPLOYMENT AND NAVIGATION (CADNAV) SYSTEM

The CADNAV system was used to control and monitor the cable deployment operation. The CADNAV system is integrated with surface navigation equipment, underwater tracking equipment, and the LCE equipment. It provides in real time a set of displays which compare actual cable lay parameters against the desired parameters. This information is used to modify, when required, ship speed, ship course, and cable payout speed and tension.

The majority of the CADNAV system is located in a custom-fitted 20 foot ISO cargo van. A remote monitor, located at the helmsman's station in the plough control van, provides steering displays and a myriad of other information.

A FUGRO Services DGPS was the primary surface navigation sensor. The current GPS constellation provided 24 hours a day, three dimensional coverage over the Bass Strait area. Navigation accuracy was in the 2 to 5 meter Circular Error Probable (CEP) range. The DGPS reference correction was transmitted to the vessel via a satellite telemetry system. An uninterruptable power supply (UPS) was used to provide power to the CADNAV system.

All critical elements of the shipboard CADNAV system are redundant. A failure in any part of the shipboard system would not have degraded system performance. A failure of the satellite could have resulted in non-differential GPS positioning accuracy, 25 meters CEP with selective availability (SA) off and 25 to 100 meters CEP with SA on. This occurred infrequently during the installation operation, and for very short periods of time (less than 5 minutes) which did not affect the operation.

The CADNAV system monitored and logged the following plough information throughout the installation operation.

- LCE cable payout
- Differential Global Positioning System (DGPS)
- Vessel's heading, pitch and roll sensors
- Cable burial depth (meters)
- Water depth (meters)
- Tow tension at plough (kg)
- Vertical tow angle at plough (degrees)
- Plough heading
- Estimated tow speed (kph)
- Plough pitch angle (degrees from horizontal)
- Plough roll angle (degrees from starboard)
- Port skid depth (meters)
- Starboard skid depth (meters)
- Altitude (meters)
- Horizontal tow angle (degrees)
- Date/time
- Tow cable tension on the vessel (kg)
- Tow cable length out (meters)

Interactive monitors were provided to the navigation operator, the helmsman, and the plough operator, to guide and direct installation activity.

Throughout the cross-strait cable deployment, the installation vessel maintained course and speed as indicated by the bridge CADNAV monitor or as specifically directed by the Installation Director. The CADNAV system displayed the planned cable deployment route including all way points, cable transition areas, and joint boxes, as well as any major obstructions or features identified in the route survey report.

Along the cable route, the installation vessel remained within a cable deployment corridor defined by the present sea state conditions as described below:

Beaufort sea state 3 or below	25 meters
Between sea state 3 and 5	50 meters
Above sea state 5	100 meters

13. CONCLUSION

The BS-1 cable system was successfully installed using the ship-of-opportunity approach, in a part of the world well-known for bad weather. In fact, the operation was exposed to worse than average weather conditions, and suffered through a total of 31 weather delay days.

The two major weather delays were responsible for the two additional at-sea joint boxes in the system for a total of 12 joint boxes.

A typical, relatively inexpensive, oil-field tug/supply boat was quickly and efficiently mobilized for three very different operations; the cable route clearance operation, the cable installation operation, and the PLIB operation. Personnel and equipment from two different organizations (SAIC/MariPro and OTECH) were successfully integrated into a working system, onto a vessel with a crew unfamiliar with cable installation and burial operations. The CADNAV navigation system was essential to the quick and relatively painless integration of these systems. The vessel operators quickly learned to operate the navigation system to maintain a true vessel course.

The cable itself was not damaged in any way by the installation operation, and specifically the installation equipment. The cable plough, the cable engine, and the remainder of the deployment equipment was relatively gentle to the cable.

14. ACKNOWLEDGEMENTS

I would like to acknowledge the valuable and excellent contribution by the following groups comprising the installation team.

TELSTRA	-	System Purchaser
Alcatel TCC	-	BS-1 System Prime Contractor
SAIC/MariPro	-	Installation Contractor
Oceaneering	-	Plough and ROV Operators
Australian Offshore Services	-	Vessel Operators
Port of Geelong	-	Port Services and MASA Site
Victorian Regional	-	Forklift and small crane Stevedores (VRS) support
SAVA Engineering	-	Steel fabrication and welding services
Barry James Cranes	-	Heavy crane services
Fugro Services	-	DGPS system

FINANCING THE GLOBAL INFORMATION INFRASTRUCTURE

by

LIONEL H. OLMER, Esq.
Partner
Paul, Weiss, Rifkind, Wharton & Garrison

INTRODUCTION

Economic development is inextricably linked to an effective telecommunications infrastructure. Increasingly, information technologies drive progress in other fields of endeavor and are a major force in creating new jobs, attracting investment, increasing competitiveness and improving standards of living among rich and poor nations worldwide.

To help disburse the benefits of information technology worldwide, the U.S. government has spearheaded the initiation of the Global Information Infrastructure ("GII"). The GII is designed to expand and deepen the international telecom system. Vice President Al Gore introduced the U.S. proposal for the GII at the March 1994 International Telecommunications Union ("ITU") Conference in Argentina, where it was included in the Buenos Aires Declaration adopted by the conference. Since then, the concept of the GII has been endorsed around the world.

Today, I would like to discuss a component of the GII that is essential to its success: financing. I've chosen the subject of finance as the focus of my paper for two reasons. First, all good national and international intentions aside, financing will be the lifeblood of information infrastructure development in the future, as it has been for general infrastructure development in the past. Second, financing has broad implications for the Asia Pacific Telecommunity (APT) and Asia Pacific Economic Cooperation (APEC) initiatives to develop on Pacific Information Infrastructure (APII). Financing issues will factor dramatically in the success of the APII regional agenda, which includes improving developed countries' telecommunications networks and linking the Asia-Pacific region to telecommunications networks around the world.

In this speech, I will use the GII as a springboard for discussing the impact of financing on transnational information infrastructure initiatives. I will begin with the GII vision as it relates to developments in the telecommunications sector in the Asia Pacific region. Next, I will examine the financing of telecommunications infrastructure development in the region by highlighting the pros and cons of the various finance sources. Finally, in light of the foregoing, I draw some conclusions concerning the future challenges facing governments in attracting investment essential to telecom infrastructure development.

I. THE GII INITIATIVE AND THE DEVELOPMENT OF TELECOMMUNICATIONS IN THE ASIA PACIFIC REGION

The GII is less a formal program than a vision of using information technology to assist in the creation of a global marketplace for goods and ideas. It is based on five principles, which were incorporated by the 185 members of the ITU who formulated the Buenos Aires Action Plan, and used by the G7, CITEL, and APEC as the basis for their own Information Infrastructure principles: (1) encouraging private investment; (2) promoting competition; (3) providing open access; (4) creating a flexible regulatory environment; and (5) ensuring universal services.

Each of these principles directly and indirectly implicates an overarching question, the answer to which is a condition precedent to building the GII: that is, how is it to be paid for? This question becomes more difficult, and the problem becomes more acute, when one considers the substantial telecommunications infrastructure needs of lesser developed countries (LDCs), as illustrated in the Asia Pacific region.

The Asia Pacific region is fertile territory for turning the GII vision into reality. It boasts an enormous market of more than three billion consumers, one-third of whom will live in "middle-class" households early in the next century. It has 25 percent of the world's wealth, with a combined GDP of $5.5 trillion. A number of countries in the region, including India, Indonesia, Singapore, South Korea and Thailand, have experienced consistent double-digit economic growth in real terms in recent years. As a result of this overall economic development, the telecommunications infrastructure has also been growing in many of the region's countries in recent years.

Unfortunately, in the midst of the concrete successes in the region, there is a gap in access to telecommunications services between advanced developed countries (ADCs) and LDCs. That disparity operates on a world-wide basis. According to the ITU, over four billion people, 80 percent of the world's population, have no direct access to a telephone. The Asia Pacific region comprises more than half of the world's population, yet only 17 percent of the world's telephones. According to the World Bank, the more than 2.8 billion people in Asia's poorest countries (1) have access to only 25 million telephones.

As a result of this situation, a number of countries in the region, including China, India, Indonesia, Malaysia, Thailand and Vietnam have made a high priority of the expansion and modernization of their telecommunications sectors. China, for example, plans to install 8 million new telephone lines each year until 2000. Indonesia expects to double its telephone lines by 2000.

Such projects are extremely expensive. India's Ministry of Posts and Telecommunications has estimated that before the end of the century it will need to meet extra ordinarily high levels of demand: 32 million additional basic telephone lines at an estimated cost of $38.4 billion; 2 million new cellular subscriptions at $8 billion; and 5 million pager subscribers at $800 million. With additional value added services, the total comes to approximately $50 billion, which could well be an underestimate.

According to the World Bank and the ITU, LDCs need a minimum of between $12-30 billion per year to provide basic telephone access to their citizens by 2000. The challenge facing many of the countries is to determine how to obtain the funds to carry out such a massive development program.

2. EVALUATING SOURCES OF FINANCING FOR TELECOM INFRASTRUCTURE PROJECTS

Worldwide investment in telecommunications infrastructure is expected to exceed $200 billion annually beginning in the year 2004. According to the ITU, worldwide investment in the telecommunications sector amounted to more than $380 billion between 1990 and 1993. Despite that substantial investment, most of the world's population does not have access to telephone service.

For the GII to become a reality, enormous financial resources for telecom infrastructure development must be made available in countries where they are now scarce. It is important to identify and evaluate trends in public and private telecom finance and the strengths and weaknesses of different sources of financing in order to determine how -- indeed whether -- financing gaps can be closed.

Public Finance. Public sector financing has as its source both governments and bilateral and multilateral development agencies, including development banks. Government funds have traditionally played the largest role in financing telecommunications infrastructure development. Such financing has allowed governments to maintain control over a sector most central to their national security interests. In some industrialized countries, such as the United States and Japan, governments have supplemented or substituted public finance with licensed monopolies, sometimes government-owned.

Public financing of infrastructure projects, whether carried out by governments directly, or indirectly through support from development banks, has identifiable benefits. Governments tend to be far more committed to the goal of universal service than are private entities.

Nevertheless, many problems plague the future of public financing's role as a primary finance mechanism for telecommunications infrastructure. The major drawback to relying on public finance is simply that there is not enough of it to go around. Even in the richest countries, the pressures on public treasuries outstrip funds available for large telecom infrastructure projects. In LDCs, the limited funds available for telecom development are completely inadequate for the task, and development banks such as the World Bank are unable to fill the funding gap because they generally cannot lend without government guarantee of their loans. Moreover, telecommunications infrastructure is but one of a number of important priorities competing for development banks' funds. For example, in 1992, only $2.4 billion was available from development banks for telecommunications loans worldwide, accounting for less than two percent of the banks' portfolios.

Lending criteria applied by development banks may also make public financing through such institutions infeasible or unattractive for developing countries. In the area of power production, the World Bank announced a new policy that will require countries to pursue the commercialization and privatization of their electricity sectors. The massive reforms called for by the Bank guidelines require encouragement of entrepreneurial activities and reduction of government interference in day-to-day power company operations through the establishment of transparent regulatory processes.

Public finance shortages for telecommunications infrastructure development have serious implications. For one, regulatory disincentives in developing countries, including restrictive treatment of income earned on loans and burdensome and unpredictable reserve requirements, have created a degree of private lender dependency on guarantees from public finance agencies. In some cases, private lenders may be willing to provide financing only when public finance agencies sponsor parallel financing. If regulatory problems should then arise, the public finance agencies benefit private lenders by tackling the problem and finding a solution that will apply equally to all lending parties.

It is critical that the members of APEC, APT, and the ITU find solutions to the problem of public finance. Private infrastructure projects are generally financed on a project finance basis. When faced with enormous total project costs, companies must find an outside source of debt. As long as commercial banks are hesitant or unwilling to provide loans for long-term projects that have not developed a track record in certain countries - particularly those where political risks are high - public finance agencies will be the only viable source for project debt. Hybrid finance, which I discuss later, promises to provide innovative solutions to traditional problems of public finance, but must still prove itself in practice.

Private Financing. There have been exciting developments in private telecom investment in Asia in recent years. In 1990, there were only two telecommunications companies from the Asia Pacific region (other than Japan) traded publicly on international equity markets. Now there are almost

1047

thirty, and, according to some observers, there could soon be close to sixty publicly traded Asia Pacific telecom companies.

Sources of foreign private investment in the Asia Pacific region have changed over time. In the early 1980s, banks accounted for more than 77 percent of the foreign investment in emerging markets. However, by 1993, institutional investors such as pension funds, mutual funds, and investment companies accounted for some 75 percent of investment in emerging markets, with banks making up only 25 percent.

Foreign investment in the region is clearly on the rise. For example, Thailand's restructuring of its telecom sector has attracted over $5 billion of foreign investment in the last two years. Restructuring programs in India, Indonesia, and the Philippines, might also result in increased private investment in those countries. China is planning large-scale infrastructure development programs and is attracting substantial investor interest.

China's rapid expansion and modernization of its telecommunications infrastructure will be extraordinarily expensive. As a result, it is forced to explore new ways to finance the effort. The Ministry of Posts and Telecommunications plans to spend $52 billion by the year 2000 to double the capacity of the network. It expects to raise some $7 billion of that amount from private sources. A joint venture of the Ministries of Electronics Industry and Railways, and the People's Liberation Army plans to spend $15 billion by 2000 to develop its own collateral telecom network. Much of that financing will be dependent on foreign sources.

While foreign companies still are not allowed to own telecom services in China, the Chinese government and potential foreign investors have proposed a variety of other investment approaches, from equity-linked lease arrangements, to a Ministry of Posts and Telecommunications plan to form a direct investment fund designed to raise approximately $200 million from overseas institutional investors. However, foreign investment will likely remain limited until the foreign ownership ban is lifted and the Chinese regulatory environment becomes more transparent and predictable.

Vietnam appears to be following a path similar to China. It has decided to break the monopoly of its state telecom company by allowing the establishment of a rival military telecom company. The plan is part of the country's attempt to increase telephone distribution dramatically by making a $2 billion investment in infrastructure development. According to the Wall Street Journal, a Swedish company, Comvik, has signed a $169.9 million contract to set up a mobile phone network with the former state monopoly. A number of U.S. firms are vying to install one million lines for $1 billion in a deal being considered by U.S. investment banks. Despite that activity, Vietnam still does not allow foreign companies to participate in joint ventures, preferring more easily dissolvable business cooperation contracts. Ultimately, as in China, foreign investors may be reluctant to undertake serious business risks without an equity holding in an infrastructure project.

The Indian government has taken private bids on the expansion of its telecom system. Planners expect telecom liberalization to yield India as much as $8 billion in license and access fees by the year 2000. The Department of Telecommunications plans to use those funds to expand the telecom network to underserved areas. Of the $20 billion needed for the landline telephone upgrade, observers expect approximately one third to be raised from equity investments, with a 51%-49% split between Indian and foreign partners. The rest, more than $13 billion, will have to come from Indian and foreign debt markets.

Unfortunately, India remains, for investors, an unpredictable and risky environment. Regional authorities might try to change some of the features of contracts after they have been agreed to by the central government, as they have in the energy sector, making foreign investors hesitate or unwilling to bear the uncertainty. Labor strife might also affect telecom investment; for example, in June 1995, many of the country's telecom workers, afraid of the impact of privatization, struck for job security.

In countries that do not have the public or private funds to finance their infrastructure development at home, private financing raises the specter of foreign ownership. In most countries, the telecommunications sector is considered to be a national security concern. The examples of China, India and Vietnam highlight the dilemma of countries that need foreign investment because they lack internal funds, yet fear its effects and influence, and therefore restrict foreign investment. Their ambivalence toward foreign investment might cause investors to put their funds to other uses in countries with more hospitable business climates.

How and whether to provide universal service is another issue raised by private investment. Private service providers, because of their responsibility to turn a profit, often focus their efforts on serving the most profitable parts of countries, such as urban areas, while avoiding less profitable rural and sparsely populated areas. Private telecom companies must answer to distant stockholders and market forces. In addition, private investors are also likely to choose to invest in those countries that present them with the best returns. Governments, especially democratic governments, answer to their citizens, and are, in theory, more likely to aim to achieve universal coverage.

Hybrid Financing. While increased public and private investment in telecommunications and information technology is flowing to a number of developing countries, those countries' needs outstrip the available resources. As a result, innovative methods of combining public and private finance are needed to make the most of the funds and the expertise of each sector.

One of the newest and most promising of the public/private partnership proposals is WorldTel, a private financing agency created this year with the support of the ITU. WorldTel has the sole purpose of helping developing countries find investment capital for telecommunications infrastructure projects. The theory behind WorldTel's approach is that the most difficult step in telecom infrastructure development is the first one -- providing basic service to as many people as possible. WorldTel's organizers believe that people demand and get more dedicated and sophisticated services as their wealth rises, after they get their feet in the telecom services door.

While targeted at many of the world's poorest countries, WorldTel will evaluate projects in client countries on economic grounds, to both meet the needs of client countries and investors. Client countries will be selected on the basis of their willingness to create positive regulatory and business environments. Because WorldTel is focused on developing nations, it will orient its efforts to tailoring financial support to the needs and constraints of the client countries, providing advice and innovative solutions along with direct finance.

WorldTel is designed to impart skills as well as funds. It is meant to be a comprehensive partnership with countries that have the political will to reform their telecommunications sectors but do not have the human or financial resources necessary to carry out such reforms. In addition, WorldTel will focus on providing access to communications services on as wide a scale as possible to underserved communities primarily through shared facilities.

Equity in WorldTel will be limited to private financial institutions, although governments and telecommunications operators and vendors will be invited to participate in specific projects through debt or equity investments. According to the ITU, potential investors including Salomon Bros., Lehman Bros., and Goldman Sachs have pledged some $500 million to WorldTel. The project is also endorsed by the sponsors of a McKinsey & Co. feasibility study, including: Ameritech, AT&T, Burgan Bank of Kuwait, Cable & Wireless, NEC, Nokia, Sprint, Teleglobe, Telekom Malaysia, and Telstra.

WorldTel will be run by an Assembly of Governors primarily composed of client countries which would make contributions to obtain a seat in the Assembly, and a Board of Directors, elected from the private shareholders that will establish investment criteria and appoint and oversee a management team.

Financing the GII will continue to be a profound challenge, but one that must be met if the GII is to become a reality. The lessons of experience in public, private and hybrid forms of finance show that international institutions, national governments and private firms must devise novel approaches to the business and regulation of global telecommunications in order to realize the GII.

3. CHALLENGES FACING GOVERNMENTS IN FINANCING TELECOM INFRASTRUCTURE DEVELOPMENT

In May 1995, telecommunications and information ministers of the Asia Pacific Economic Cooperation ("APEC") met in Seoul, South Korea to develop a regional approach to the GII. In launching an Asia Pacific Information Infrastructure ("APII") initiative, the participants paid special attention to the needs of developing countries in the region. Narrowing the infrastructure gap between advanced and developing countries in APEC is one of the ten, overarching principles announced in the Seoul Declaration adopted by the meeting.

Among other provisions, the APII Action Plan, adopted at the meeting, calls on international financial institutions such as the Asian Development Bank, the Inter-American Development Bank, and the World Bank to support private sector/public sector investment partnerships in the development of information technology and telecommunications infrastructure in member countries.

I believe that APEC's approach to the problem of financing telecom infrastructure is both prudent and promising particularly since developments to date clearly reveal that neither the private sector nor the public sector, acting alone, will be able to finance development of the GII.

Public/private investment partnerships could make the funds of each group of investors go further by segmenting and focussing the specific objectives of each participant. For example, development bank funds could be targeted at supporting regulatory reform and increased governmental transparency in bidding and contracting. Private and governmental funds could be used to assist privatization and infrastructure development. This kind of cooperative effort could have a multiplier effect, thereby making the most of limited funds. The need of private investors for adequate returns and of governments for expanded infrastructure, universal coverage and technical assistance could both be served.

Governments must facilitate this kind of partnership by providing incentives to private companies to participate in infrastructure development. I believe that the recommendations of the Agenda for Cooperation for the GII, published by the U.S. government in February 1995, provide a sound basis for identifying the appropriate kind of incentives that governments in the Asia Pacific region must consider, including:

- Creation of a stable operating environment supported by transparent regulation;
- Establishment of fair and open bidding practices for all communications and information infrastructure projects;
- Recognition that potential investors require a return on capital;
- Establishment of sound repatriation policies; and

- Demonstration of a political commitment to private investment through appropriate modifications in the legal and regulatory framework, including liberalization of foreign investment and ownership rules.

In addition, I believe that it is important for governments to promote and enforce rules of fair competition. Last year, at this conference, I reviewed the efforts of Asia Pacific nations to encourage privatization and competition and concluded that such trends have been closely related to a dramatic expansion in telecommunications infrastructure in the region. Excellent examples of such an approach can be found in the experiences of Indonesia, Malaysia, and Thailand which allowed private development of cellular telephone systems while maintaining publicly-owned and controlled landline telephone systems. Those cellular systems have begun to challenge the landline systems for basic service clients, and have introduced competition, lower prices and better service into previously uncompetitive environments. As a result, the cellular industry has experienced rapid growth in the Asia Pacific region as a basic telecommunications service. Private investment, not public finance built that growth. But, it is instructive to note and deserves emphasis, on enabling environment for private cellular providers, created by governments that encourage competition, contributed to fostering increased private investment and the growth of the industry.

CONCLUSION

Financing the development of that infrastructure in the world's poorer nations is a daunting challenge, yet the combination of increasing openness to private sector telecom investments, and the emergence of innovative private sector/public sector investment partnerships -- such as the WorldTel initiative -- makes realization of the GII a more realistic possibility.

NOTE:

(1) Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Pakistan, Sri Lanka, and Vietnam.

TAKING ADVANTAGE OF THE INFORMATION ECONOMY

Paul Mallam, Partner
Blake Dawson Waldron
Sydney, Australia

This paper examines the policies and regulatory approaches that need to be adopted for countries in the Pacific Rim to benefit from the growing "information economy". The paper places these issues in an Australian context, although the issues are common to most countries in the region. The main theme of the paper is that to succeed in the information age, all countries will need flexible labour arrangements, overcome distribution bottlenecks and increase competition in the carriage market, through appropriate telecommunications policies.

INTRODUCTION

We presently stand on a cusp in human history, in which our developed countries are being transformed from industrial economies to information economies. In the United States, where this transformation is most evident, information and entertainment is now the largest export sector by value. On a global scale, the exponential growth of the Internet is a further example of this transformation.

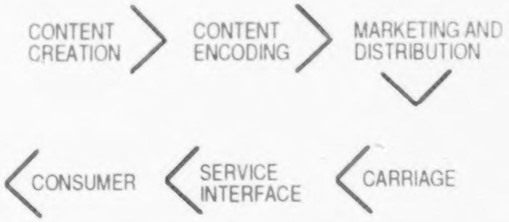
The future economic development of most countries in the Pacific Rim will largely depend on their ability to attract a share of the investment and wealth created by this transformation. The margins achieved for all physical products, including technology hardware, are shrinking. Increasingly, the performance of national economies will be linked to their ability to provide "value added" services in a globalised information economy. This trend is occurring through a combination of:

- The emergence of new service opportunities created by technological advances;
- The increased internationalisation of trade in information-related services, which will be assisted by the digitisation of all information and entertainment;
- The development of new industries, such as interactive multi-media and on-line services.

The challenge for all countries will be to position themselves in an information world. The national economies which succeed will be those who enjoy a trade surplus in information and entertainment services. That trade surplus will be achieved by importing service users - the on-line equivalent of importing tourists - rather than importing information and entertainment services.

GOVERNMENT POLICY

This paper examines what must be done to encourage this development, in terms of Government policy. For Governments, this challenge requires an understanding of the key elements of the "information" food chain:



Successful economies will be efficient and competitive at each stage of this process. If they are not, then they will price themselves out of the global information market, in much the same way that some of the larger Western economies priced themselves out of the consumer electronics market. However, the difference between the two is that it will be difficult, if not impossible, to erect tariff and other trade barriers in an information economy. Once all information can be reduced to bits, it is easily transferred across international boundaries.

The paper places these challenges in an Australian context, although the issues are common to most countries in the region. One point of distinction is that until now Australia has enjoyed the luxury of isolation, which historically acted as a trade buffer. However, there has been increasing recognition by Australian industry and regulators alike that distance will become irrelevant to the "information trade". In 1990, most in Australia thought that new information services would be imported by satellite. However, the Internet slipped below the gaze of regulators and business, providing a massive inflow of information services. Australia is now the highest per capita user of the Internet in the world.

The irrelevance of physical distance also presents an opportunity for Australia, which is dominated by its geography. Historically Australia's distance from the rest of the world has been a impediment to the efficient export of manufactured goods. These facts have given Australia a curious economic profile. It is a relatively wealthy and advanced country, with one of the highest penetration rates of business and consumer technologies, such as personal computers, in the world. Nevertheless, about 40% of its exports continue to be from unprocessed raw materials, giving it something of the characteristics of an underdeveloped country.

Australia's dependence on its raw materials has resulted in a declining per capita standard of living, relative to other countries in the world. There is an increasing realisation that if Australia is to survive in the 21st century, it must develop an economy which is extremely efficient in the production of information services. This challenge has been the subject of a number of Government-sponsored reports, which are touched upon in this paper. These reports have covered a range of related issues, from copyright reform (Report of the Copyright Convergence Group) to the development of a broadband infrastructure (Report of the Broadband Services Expert Group), which focus on the need to transform the Australian economy to an information-oriented economy.

CONTENT CREATION AND ENCODING

The first steps in the information food chain are content creation and encoding, comprising the physical process of creating an information or entertainment product and converting it into a transmissible form. Traditionally, there have been four prerequisites for the development of a "content" industry:

- Finance or venture capital to support content developers;
- A talent pool capable of creating content;
- An appropriate intellectual property regime to protect content;
- Marketing and distribution support.

The entire process of content creation is in a state of rapid flux. Content creation using conventional technologies has been relatively expensive, whether the product is a newspaper, book or audiovisual production. While there will continue to be a demand for expensive Hollywood productions, the cost of content creation is falling dramatically, especially with new production technologies. With digitisation of content, this trend will continue to the point where each "wired" consumer is a potential creator of content of a relatively high quality.

This has implications for all countries within the region. A major impediment to significant content production has been the provision of finance or venture capital. However, this barrier to entry will fall, in line with falling production costs.

Falling production costs coincide with emerging production opportunities, particularly in multi-media, educational, games and other on-line applications. In this environment the key prerequisite is the development of a labour pool with a core set of production skills. This will usually involve multi-disciplinary teams, whether the content being created is a multimedia game, an educational product or a data-based on-line service. The human capital necessary to develop these teams must be supplied through education and training or, initially, the importation of skilled persons.

Thus, for example, restrictive migration policies can be an impediment to the creation of content-based industries, particularly if they are to succeed internationally. Most of those industries will increasingly require a reasonably free flow of labour across borders.

In addition, the multi-disciplinary nature of content creation usually means that content is most efficiently created in a team environment, in which persons are multi-skilled. This is particularly an issue for Australia, where our labour laws are perceived as having relatively rigid employment practices, which restrict the deployment of labour. However, over the past several years labour reform has overcome many of these restrictive practices and this trend is continuing.

Of particular importance to future growth will be production management skills of a high level, which are able to blend the disparate cultures and work modes of differing forms of production. For example, successful multi-media productions will need to blend the cultures of film, print and software production.

The third key ingredient for content industries is intellectual property protection. For most information and entertainment services, intellectual property protection will usually be in the form of copyright. Only an efficient copyright regime will enable the work to be fully exploited. Thus, a copyright regime is both a prerequisite and an opportunity. Countries with an efficient copyright regime stand a better prospect of attracting a substantial content production industry to their borders.

Notwithstanding this opportunity, rapid advances in communications technology, and in particular in digital technology, represent a major challenge to copyright laws because:

- Almost any "work", in a copyright sense, will be capable of being distributed over the telecommunications network;
- A work can be downloaded and stored inexpensively;
- A work can be manipulated easily; and
- A work, including a manipulated work, can also be transmitted to any other point in a telecommunications network, at minimal cost.

The challenges posed by these developments can be divided into immediate and long term threats. In Australia the immediate threats have been the subject of extensive comment and a report by the Copyright Convergence Group. This Group was appointed by the Government in 1994 to examine Australia's copyright laws . It recommended that Australia's existing patchwork of rights be replaced with a general right of "communication" of a work. The Australian Government has indicated that it will largely accept the recommendations of the Group and enact them.

However, the long term technological possibilities of the information superhighway present more far-reaching challenge for copyright law. By definition, copyright depends on both a limited ability to copy or otherwise deal with a work and, where a copying or other use takes place, the ability to monitor and account for that use. However, in a digitised world, the ability to control dealings with a work potentially evaporates.

The answer to the problem of re-communication of copyright works is likely to lie in developments within telecommunications networks. Increasingly sophisticated billing software allows calls to be identified and billed on an individual basis. Combined with a digital tagging system, it would be possible to bill a person who communicates a work, providing that the communication of the work can be distinguished through its tag from any other communication. A communicator of a work could be charged a fee in respect of that communication. Such systems would have the effect that those controlling the network would also have control over the way in which any copyright system is administered. Given the potential for these developments, it is not difficult to understand why large holders of rights (primarily entertainment and software companies) are increasingly forming alliances or acquiring interests in telecommunications networks. It is only through the telecommunications network itself that the value of the rights they hold will continue to be protected. However, this development of itself creates competition issues, touched upon below.

The fourth prerequisite to content production is marketing and distribution, also discussed below.

MARKETING AND DISTRIBUTION

Content creation of itself is not enough to develop an information economy. The content must be packaged and marketed as a service. In Australia, conventional wisdom is that there are three stages in the development of content-related services:

CD ROM
ON-LINE SERVICES
FULLY INTERACTIVE VIDEO

In framing appropriate policies, much will depend on where individual countries sit in this development. Although these phases are seen as evolutionary, they obviously represent "windows of opportunity" which will overlap and develop in parallel - for example, it is not necessarily the case that on-line services will entirely replace CD-ROM, in the same way that it is not necessarily the case that pay TV will entirely displace video rental. Internationally, the CD-ROM cycle is already maturing. For example, in 1993 sales of the Encyclopaedia Britannica on CD-ROM exceeded sales in hard copy.

The marketing and distribution of content is usually the most expensive aspect of the information chain, and consumes the largest slice of gross revenue. Significantly, as we move to on-line services and fully interactive video, the costs of physical distribution are falling. Thus an information product can be distributed at low cost, especially on the Internet. The Netscape program, which was initially marketed free on the Internet, is an example of the distribution capability of the Internet.

Nevertheless, as most businesses providing services on the Internet have discovered, while the Internet theoretically provides access to millions of customers, it is very difficult to be "noticed". Packaging and marketing encompasses the integration of the content into a broader menu of services, which are targeted to the consumer.

Most packaging and marketing occurs through established international distribution networks, which usually have a marketing base in publishing, broadcasting, film, video games, or some other medium. Those established networks are investing very large sums to become the packagers and marketers in the information economy. Internationally, they enjoy the advantages of:

- a large capital base (in most cases);
- the ability to spread capital over a number of production "risks", at any one time;
- an established distribution network and pool of marketing skills;
- brand awareness amongst consumers.

Content producers in most countries face a difficult task in packaging and marketing their products outside established distribution networks. This is not to suggest that opportunities for emerging packagers and marketers of content do not exist. Nevertheless, in an international context, most content producers will need to rely on an existing distribution network.

This has a number of implications for Government policy. Firstly, the opportunities for content producers will be maximised where there are a number of international marketers competing for their product. However, there are relatively few major international marketing and distribution networks, which potentially creates a bottleneck constraint. For most countries, that constraint will be best overcome by encouraging existing marketing networks to either invest locally or to partner with local content producers. This gives existing networks some "stake" in local content production, thereby maximising the opportunities for local content producers. This was a key recommendation of "Commerce in Content", a consultancy report commissioned by several Australian Government agencies to advise on policies to encourage multi-media production. Although the report focussed on multi-media production, the need to attract investment by major international marketing networks is common to most content production.

Furthermore, efficient competition law mechanisms are necessary, to ensure that the emerging opportunities presented by the information economy do not result in increased concentration of marketing networks, thereby stifling development of a content industry. The most difficult competition law issues are likely to arise where mergers or alliances create vertical integration between the content producer, the distribution network and other parts of the information chain, such as the carrier.

CARRIAGE

Carriage is the process of sending the packaged product to the user. The key to carriage of information and entertainment is bandwidth. Bandwidth becomes the "shipping lane" through which the international information trade will take place. To participate in an international information economy, national economies will need abundant bandwidth at low cost with reliable delivery characteristics. However, that can only be achieved by making every element of carrier service fully contestable, so that consumers do not face tariffs driven by monopoly rents. This issue is particularly critical for Australia, which has a shortage of international bandwidth. A recent inquiry by Australia's telecommunications regulator, AUSTEL, found that the national carrier, Telstra, remains dominant in international carriage. This dominance was found on the basis of a number of factors, including incumbent advantage. It is expected that Telstra's dominant position will be reduced as Australia's telecommunications regime is liberalised. The Government's recent liberalisation initiatives, announced on 7 August 1995, are further discussed below.

A competitive carrier environment will obviously encourage the provision of bandwith. However, the unmanaged liberalisation of telecommunications by the simple device of introducing more carrier licences may not be enough. Most countries in the region, including Australia, are moving from state-owned monopoly PTTs which have a significant incumbent advantage. To overcome this advantage, and create a genuinely competitive environment, there will usually be a need for competition mechanisms such as managed interconnection, as well as appropriate competition laws to prevent an incumbent's misuse of market power through the adoption of proprietary standards or other strategic chokepoints, which stifle the competitive entry of other carriers and therefore their ability to offer competitive services.

On 1 August 1995 the Australian Government announced that Australia's telecommunications regime will be liberalised from 1 July 1997. Key elements of the Government's Telecommunications Policy Principles are that there will be an unlimited number of carriers, each of which will have rights of interconnection with all other carriers. Australia's competition regulator will have powers of arbitration, if terms and conditions of interconnection cannot be agreed upon. It is envisaged that licences will be issued and interconnection negotiations take place prior to 1 July 1997, so that the effect of competition is not delayed. This liberalisation will be critical to the development of an information economy.

It is also relevant that a variety of carrier platforms are emerging, as viable technologies to support an information trade. This leads to two points, in terms of government policy:

- Firstly, policy should not be prescriptive, in terms of "preferred" technologies. Technological neutrality is important, so that markets, and those who bear market risk, determine the best platform for a particular information service.

- A pluralistic approach, in terms of platforms, also increases the available means of distribution. The greater the distribution, the greater the access of content creators to markets.

The Government's Telecommunciations Policy Principles have encompassed this approach.

USER INTERFACE

The user interface is the conversion and connection point between the information "bits" transported by carrier and the consumer and/or user. This presents a large window of opportunity for all countries with a significant software industry. The success of Netscape is an example of the strong consumer demand for software to navigate and manage connection with the Internet. Windows 95, which has an Internet connection, is another example of the recognition by major software providers that the consumer interface will be a key gateway in the information economy. As with marketing and distribution networks, these gateways are potentially a bottleneck, which can limit or regulate access to certain categories of services or restrict interoperability between gateways.

Decisions regarding the nature and type of user interface will be made by consumers themselves, through the global marketplace, at least until interface standards and protocols are established. Even then, there will be significant opportunities for smaller software companies to provide various support services which assist in the operation of user interfaces, by for example making them interoperable, or which satisfy particular niche needs.

Government policy will have a limited role in this area. One area of potential concern is appropriate competition mechanisms which prevent distribution bottlenecks being created by a proprietary user interface. However, as the various types of user interface will be decided internationally, the efforts of the Government in most regional countries will be at the margin, in terms of significant impact on interface systems. The primary role which can be undertaken by those Governments, including Australia, is to encourage local software skills, so that a local software industry can provide value added interface services which build on the major international forms of user interface.

CONCLUSION

In summary, there are a number of key areas on which Government policy will need to focus, in order to create a domestic economic environment which is positioned to take advantage of the information economy. These will include:

- In relation to content creation, the development of relevant skills through appropriate education, training, importation of labour (where appropriate) and flexible labour principles. In addition, an efficient copyright regime will be important. Although digitisation poses a long term threat to copyright, copyright laws will continue to have their place.

- Policies which encourage major international marketing and distribution systems to invest locally or develop alliances and partnerships with local content creators, combined with competition mechanisms to prevent marketing bottlenecks.

- A competitive telecommunications environment, which is capable of delivering an abundance of bandwidth at low cost, with reliable delivery characteristics. Generally, Government policies which mandate or prefer one method of carriage or technology over another are likely to stifle the development of an information trade.

- Most probably, a limited role in relation to user interfaces, although competition law could play some part. For smaller regional countries such as Australia, the development and maintenance of a local software industry will be important.

Infrastructure: A Revisionist Plea

Donald M.Lamberton
Visiting Fellow, Urban Research Program and
Co-ordinator, Telecommunications and Information
Activities Program, Centre for Law and Economics,
Australian National University, Australia

ABSTRACT

In the telecommunications context, infrastructure is rarely defined and is narrowly conceived in terms of telecommunications equipment. This is a reflection of engineering/technological preoccupations, with a consequent neglect of the creation of institutions, e.g., intellectual property rights, regulatory systems and co-ordinating mechanisms, and necessary complementary investment, e.g., information stocks, information-handling capability.

Such a focus on one component of a complex, dynamic system is inevitably misleading: private and public investment in related components, both substitutes and complements, are excluded in research and policy-making; significant sequences and lags are ignored; productivity gains and growth rates are overestimated and investment outlays underestimateded, as are the scope and time dimensions of management and policy processes.

A careful and comprehensive definition of infrastructure, combined with analysis of the role of organizational capital and the development of an economically significant taxonomy of information, is needed for understanding of the causal interactions between telecommunications and economic and social development.

Applied to the Asian-Pacific region, this approach suggests that the ITU calculation of $ investment requirements is a serious understatement, unless it is complemented by realistic assessment of complementary investments needed and those imposed by the slower process that will prove possible.

In the hey-day of manufacturing, the capacity percentage at which the steel industry was operating was a significant indicator of the state of the economy, because steel products were so intricately interwoven with so much of industrial activity. Those interrelationships have been measured and analyzed in the course of input/output research. Thanks to information economics, we have some basic statistics of the structure of the information economy, the interrelationships between the production and the use of information goods and services, and we have sharpened our thinking about the role of information in economic processes. Information is now viewed in a variety of economically significant ways: as a resource, commodity, perception of pattern, and constitutive force in society (1). Its overall significance is captured in the assessment that information-handling generally is the dominant claim on resource use (2). Nevertheless, neither information nor information-handling capability is treated as capital, and economics continues to evade central analytical and policy issues by assuming that economic actors - housewives, workers, CEOs and politicians - have rich and sure information which they handle with a high degree of competence. As testimony to this evasion, the key concept of infrastructure remains nebulous and yet is overworked. As consequence, given the fluid state of technological development, there is no available indicator of information utilization that can tell us how well the economy is doing.

The prevailing view of infrastructure stems from a market modelling of the economy. An enterprise sector owns and operates firms which produce goods and services; but the system requires, first, other public resources and institutions if it is to function effectively, and, secondly, there must be an appropriate balance amongst the activities and resources within the enterprise sector. Traditionally, the first has been a matter for public provision; the second a balanced growth requirement that is expected to emerge from market operations.

Because of both serious measurement problems and the public financing of so much infrastructure, recent research on infrastructure investment has focussed on a narrow public sector ownership version of infrastructure, including transportation facilities, water and sewer lines and communication systems (3). Human capital and/or R&D capital have been excluded.

Both policy debate and popular discussion have taken the same track. Infrastructure has proved a powerful metaphor, with images of roads and bridges, dams and power stations, ports airports and teleports, tall buildings and smart buildings, and now the information superhighway. Especially in its advertising manifestations, infrastructure has been ill-defined, ranging from a melange of toll roads, railways and hydroelectric plants to 'instant infrastructure' in the form of radiotelephone equipment being dropped by parachute (4). Despite the lack of definition, this construct has been capable of generating both lobbying for substantial public funds and daydreams of big profits (5). As we shall emphasize later, the most significant omissions in these discussions have been information itself and the institutional setting in which information is used; an omission that, incidentally, contrasts sharply with the manner in which the infobahn's ancestor, the autobahn, was proferred as a symbol of national unity, as tradition harmonized with modernity (6).

The global village seems to be fading, being replaced by an industrialized information society, replete with superhighways. But just as the village was a utopia, so too is the contemplated infobahn world, for those who have accepted it as the bright future. Remember the ITU 1988 statistic that half the world's population did not live with two hours' walking distance of the nearest telephone (7). Happy or distressful as the thought might strike you, that state of the world is not cancelled out by a Newsweek picture of a Samburu warrior making a call on a cellular telephone (8).

Telecommunications systems remain "a patchwork of interconnected, but not fully interoperable, transmission networks" (9), to which can be added "alternative infrastructure" potentially available if regulatory systems are modified, from utility companies and cable television operators (10). Full interoperability depends, for example, upon changes in investment, new technology, standards and other institutions and skills.

There is a yawning gap between the narrow, engineering costing and the full cost of infrastructure as indicated by, for example, the NTIA 1993 Agenda for Action, where an "expansive meaning" took in the fully integrated physical components used to transmit, store, process and display voice, data and images and "other elements": the information itself, applications and software, network standards and transmission codes, and "[t]he people...who create the information, develop applications and services, construct the facilities, and train others to tap its potential" (11).

Similarly, the Australian BSEG report, Networking Australia's Future, declares the need to create, for example, a "culture of innovation" but in good 'technology push' tradition shows no awareness of the path-dependency of such changes (12). Presumably, there are few if any lessons from the decades of policy debate about improved management, innovation and international competitiveness as Australia hurries ahead in an effort to be among the world's leaders in information and communications services, reassured by a quite minor $ subsidy.

One might ask: what has the Creative Nation that the Clever Country lacked? (13). One answer could be historical perspective. It is useful, therefore, to reflect on the Rockfish Gap Report to the Legislature of Virginia

Relative to the University of Virginia, 1818. In a fashion familiar to us from NCLIS days and now superhighway euphoria, the objects of primary education included:

> To give to every citizen the information he needs for the transaction of his own business;
> To enable him to calculate for himself, and to express and preserve his ideas, his contracts and accounts, in writing;
> To improve, by reading, his morals and faculties;
> To understand his duties to his neighbours and country, and to discharge with competence the functions confided to him by either;
> To know his rights; to exercise with order and justice those he retains; to choose with discretion the fiduciary of those he delegates; and to notice their conduct with diligence, with candor, and judgement; And, in general, to observe with intelligence and faithfulness all the social relations under which he shall be placed (14).

I dwell upon the enduring nature of these objects and their wide scope in order to remind you that the I/O approach has not captured a great deal of socio-economic organization; it has focussed on current goods production and has failed to reckon the service sector, intangibles and institutions. These limitations bear comparison with the theory of the market economy, with its focus on the operation of established markets and its inability to say very much at all about the establishment of markets.

One is reminded of Marx and Engels grappling with all the interactions, the innumerable intersecting forces giving rise to "the historical event". Engels explained: "Marx and I are ourselves partly to blame for the fact that younger writers sometimes lay more stress on the economic side than is due to it. We had to emphasize this main principle in opposition to our adversaries, who denied it, and we had not always the time, the place or the opportunity to allow the other elements involved in the interaction to come into their rights" (15).

It may be that in the past, the publicly provided infrastructure was sufficiently separate from the on-going production activities and institutional arrangements were sufficiently stable to warrant ignoring the effects of interaction. Now, however, and particularly in the case of a general purpose technology such as telecommunications and related information activities, it seems necessary to guard carefully against the bias imparted by Marx and Engels; to analyze the interactions and the processes by which values and institutions are changed. The information economy poses a major challenge to orthodoxy as "information is not merely a good that is desired and acquired but is to some extent a commodity like others whose markets we study" (16).

MISSING ELEMENTS

Some of the missing elements seem rather obvious. From an immediate communication and information perspective, the most significant would appear to be information stocks, organizational capital and human capital. The information stock has long been recognized as having the characteristics of capital (17); one leading economist has gone as far as to argue that all expenditure on information is investment (18). Both theoretical analysis and policy formation have foundered because information has been an all-purpose concept. If we are to understand its role, there is an urgent need to develop an economically significant taxonomy of information (19).

Such a taxonomy would distinguish bewteen different kinds of information according to combinations of characteristics. At present, the one label represents a very mixed bag of information goods and services, in marked contrast to the rich variety of, for example, manufactured goods, kinds of labour, exports and imports we have available for industrial economies. Without such a taxonomy and appropriate disaggregation, there is little prospect of clarifying the debates about the direction of causality between telecommunications and economic development or even the ways in which information itself contributes to the process (20). Without such basic understanding, the long-run dynamics of telecommunications demand must remain a mystery.

Perhaps an illustration helps develop this reasoning. Given that the firms develop in path-dependent ways, that they have different histories, represent different collections of resources and their decision-makers are in different `states of readiness' when facing decisions, is it possible to make them so alike that electronic data systems can effect the complete co-ordination required for data interchange? (21)

Organizational capital is the accumulated information-handling and problem-solving capability of the particular society or components of that society, e.g., business firms. The history of both mergers and new enterprises has more than sufficient evidence that new organizations cannot be created overnight by market purchases of assets; successful firms evolve. And it has been suggested, wisely, that organization is the real wealth of nations (22).

The third missing element, human capital, has been investigated but in a narrow fashion. To a large extent, it has been viewed as created over time by formal education. It might be more useful to modify the approach to ask how information-handling capability is created.

Are there other elements? Yes. There are the vitally important institutions that control and co-ordinate activities: intellectual property rights, standards, contractual obligations, shared expectations, regulatory mechanisms. These are just as necessary to the functioning of the information economy as are the roads and bridges, telecommunications networks, and computers. They are not, however, reckoned as part of the investment, either public or private, in infrastructure.

IMPLICATIONS

The underlying premise of this paper is an urgent need for "an understanding of existing realities" (23). So in discussing implications, there will be two steps: first, to point up the more important gaps in the present perspective; and, secondly, to begin the policy analysis that could be built from the new perspective. Major gaps to be filled are:

* A taxonomy of information and and appropriate measurement so that the key variables that are modelled are adequate indicators. Current research findings on infrastructure investment are inadequate because investment in related components, either substitutes of complements, in both private and public sectors, are excluded. In a period characterized by deregulation and privatization, this omission may have great importance.

* Understanding of investment decisions in telecommunications is restricted because both substitution and complementarity processes are neglected.

* Significant sequences and lags between actions are ignored. All too often `technology' is viewed as a tap that can be turned on or off at the whim of the policy-maker; and, perhaps even more serious, institutional change is viewed in similar fashion.

* Decisions based on incomplete modelling and measurement inevitably are erroneous. Potential productivity gains, growth rates and expected profits are overstated, for example, in the realization of EDI benefits.

* Investment outlays are consequently understated, as are the time intervals to achievement of targets.

* The complexity and duration of management tasks are not anticipated, especially in such activities as mergers, alliances, innovation and the penetration of foreign markets.

* Analytically, the most significant failure is resort to 'black box' thinking. For example, the current bible of regulatory analysis (24) confesses, after some 650 pages of fine detail, that both government (as regulator) and firms have been treated as black boxes. Until the internal organizational dynamics of large organizations, as contrasted with the minute, powerless units of perfect competition theory, are taken into account, the adequacy of analysis and the effectiveness of policy must remain in question.

When we turn to the public policy dimensions a similar catalog can be compiled:

* Major policy initiatives make inadequate provision for the consequential costs and time dimension of processes they set in train.

* In particular, the fundamental role of institutional change is overlooked, e.g., in dealing with telecommunications in transitional economies (25).

* Research too is pursued in an unbalanced fashion. 'Hard' science and engineering are supplemented by what are basically marketing initiatives, to the neglect of the socio-economic insights that might be provided, on an interdisciplinary basis, by economics (especially information economics), organization science, information science, sociology, psychology and history.

ASIAN-PACIFIC REGION: EXISTING REALITIES

This paper has emphasized existing realities. However, the implications of the analytical inadequacies can be hinted at if we turn to a brief, superficial comparative examination of some countries in the Asian-Pacific region (26).

The indicators in Table 1 are very approximate. They relate to different, recent points in time and are of varying accuracy. They do not distinguish between urban and rural patterns. They do however serve to underline the needed investment in related equipment, education and institutional development that has to accompany investment in telecommunications facilities. In regard to this latter investment, the differences in international requirements between countries should be noted; likewise, the inadequacy of legal systems, e.g., legal protection of computer software, can serve as an illustration of the lag in terms of institutional development (27).

CONCLUSION

There is urgent need to abandon 'black box', 'technology push' analytical approaches to achieve a realistic perspective on the costs and investment requirements of planned telecommunications development in both developed and developing countries. This applies to both research efforts and policy formation.

NOTES AND REFERENCES

(1) S. Braman, Defining Information: An Approach for Policymakers, Telecommunications Policy, 13 (1989), 233-42.

(2) G. Eliasson et al., The Knowledge Based Information Economy, Industrial Institute for Economic and Social Research, Stockholm, 1990.

(3) E.M. Gramlich, Infrastructure Investment: A Review Essay, Journal of Economic Literature, 32 (1994), 1176-1196.

(4) OHP material.

(5) cf. H. Muschamp, Thinking About Tomorrow and How to Build It, New York Times, January 10, 1993, Section 2, 1,32.

(6) K. Rosenberg, In The Eye of the Beholder: Poetic Documentaries about Technology, Technology Review, 92 (1989), 62-68.

(7) R.E. Butler, Deregulation in the 1990s, International Telecommunications Union, March 8, 1988.

(8) Newsweek, 1995.

(9) R. Borthwick and O. Stehmann, A Strategy Towards Infrastructure in the European Union, Telecommunications Policy, 18 (1994), 616-628.

(10) ibid. 620.

(11) Information Infrastructure Task Force, The National Information Infrastructure: Agenda for Action, NTIA, US Department of Commerce, Washington DC, 1993.

(12) Broadband Services Expert Group, Networking Australia's Future.

Australian Government Publishing Service, Canberra, 1995.

(13) R. Joseph, The Politics of High Technology in Australia, Prometheus, 7 (1989), 103-128.

(14) Thomas Jefferson, The Rockfish Gap Report, in Merryn Williams (ed.), Revolutions 1775-1830, Penguin Books, UK, 1971, 193.

(15) F. Engels, Letter to Bloch, Selected Correspondence, pp.475-477, quoted at p.31 by V. Venable, Human Nature: The Marxian View, Meridian Books, 1966.

(16) K.J. Arrow, Collected Papers of K.J. Arrow: The Economics of Information, Blackwell, Oxford, 1989, 142 (Emphasis added).

(17) D.M. Lamberton, The Theory of Profit, Blackwell, Oxford, 1965; K.J. Arrow, The Limits of Organization, Norton, New York, 1974.

(18) C.C. von Weizsäcker, The Costs of Substitution, Econometrica, 52 (1984), 1085-1116. For a modern emphasis on the role of knowledge in growth, see P. Romer, Ideas and Things, The Economist, 328, September 11, 1993, 64,67-68 and R. Jones and G. Newman, Adaptive Capital, Information Depreciation and Schumpeterian Growth, Economic Journal, 105 (1995), 897-916.

(19) D.M. Lamberton, 'Threatened Wreckage' or New Paradigm?, in D.M. Lamberton (ed.), The Economics of Communication and Information, Edward Elgar, UK, forthcoming.

(20) See D.M. Lamberton, Telecommunications and Economic Growth: The Direction of Causality, in Peter Droege (ed.), Intelligent Environments, Elsevier, Amsterdam, forthcoming; J.L. Enos, The Creation of Technological Capability in Developing Countries, Pinter Publishers, London, 1991; M.J. Menou (ed.), Measuring the Impact of Information on Development, IDRC Press, Ottawa, 1993.

(21) E. Brousseau, EDI and Inter-firm Relationships: Toward a Standardization of Coordination?, Information Economics and Policy, 6, (1994), 319-347.

(22) A.G. Ramos, The New Science of Organizations: A Reconceptualization of the Wealth of Nations, University of Toronto Press, 1981.

(23) Thomas Sowell, Race and Culture: A World View, Basic Books, New York, 1995

(24) J-J. Laffont and J. Tirole, A Theory of Incentives in Procurement and Regulation, MIT Press, Cambridge, Mass., 1993.

(25) J.E. Stiglitz, Whither Socialism?, MIT Press, Cambridge, Mass., 1994.

(26) D.M. Lamberton, The Information Revolution in the Asian- Pacific Region, Asian-Pacific Economic Literature, 8 (1994), 31-57.

(27) R. Bigelow, Countries Lag in Software Protection, I-WAYS, 18 (1995), 56-59.

TABLE 1

Country	Telephones per 100 people	Radio per 100 people	TV per 100 people	Tertiary graduates % pop.	Telecom investment required ITU $m
Cambodia	0.1	11	0.8	-	25
Indonesia	0.7	15	6.0	0.6	4,500
Malaysia	10.8	43	14.8	1.4	7,500
Myanmar	0.2	8	0.2	-	300
Philippines	1.7	14	4.8	6.7	3,000
Thailand	3.1	19	11.4	5.0	6,000
China	1.3	18	3.0	0.5	30,000
India	0.8	8	3.2	-	25,000
Hong Kong	60.5	67	28.0	6.7	2,500
Australia	55.0	128	49.0	24.4	4,000

Source: ITU (International Telecommunications Union), Asia-Pacific Telecommunications Indicators, Geneva, 1993; UNDP (United Nations Development Program), Human Development Report 1994, Oxford University Press, 1994.

Financing the Development of Telecommunications Infrastructure:

Various Means to Accumulate Capital for Constructing and Enhancing Telecommunications Networks in Asian Economies

Mamoru Udaka
Research Institute of Telecom-Policies and Economics
Posts and Telecommunications International, Japan

ABSTRACT

This paper analyzes various means of financing for telecom infrastructure in Asian economies. It focuses on private investment vehicles, such as stock and bond issues, joint ventures, and concessions like revenue sharing contracts with private operators. Financial experiences in Thailand, Malaysia, and Japan provide useful models of mobilizing private capital for the development of telecom infrastructure.

1. Privatization and Finance

1.1 Needs for Privatization

Information infrastructure is regarded as one of the fundamental factors for economic development. Both empirical and conceptual studies have proved a close correlation between the growth of GDP and investment in infrastructure.

Unfortunately, the telecom sector in developing economies generally falls short of meeting the demand for telecommunication services. In order to facilitate faster economic development, governments in the developing economies must accelerate improvements and expansions in the telecom sector.

The governments in developing economies should privatize their monopolistic state-owned telecom organizations by, at least, transforming the organizations into public corporations.

"Privatization" is defined as a public organization that has sold more than half of its assets or shares to the private sector. In this paper, public-corporatization of the state-operated company is regarded as the first step to the privatization.

The privatization process in developing economies should proceed prudently. The participating governments ought to maintain some authority or hold a controlling share of the former monopolistic companies to insure development of the telecom market.

It is important to distinguish privatization in developing economies from that in developed countries.

First, the crucial difference is penetration rates of telephone main lines. Privatization processes are still ongoing in many countries, including developed European countries that have high telephone penetration rates. In developing economies, there are many villages that are not even connected to telephone networks.

Who is responsible for installing telecom facilities in non-profitable areas remains? Private capital is reluctant to enter rural telecom service markets that have little potential profitability.

Public sector involvement may be needed to insure universal service in rural areas until certain telephone penetration rates are met. Competition may not be a suitable means for the developing economies. Administrators in developing countries should direct telecom service providers to develop telecom infrastructures in rural areas when the telecom market opens to competition.

Furthermore, the availability of advanced technology is different. Telecom businesses require advanced technologies for the improvement of infrastructure. Developing economies depend on developed countries for advanced telecom technologies. Imported technologies tend to lead to patched networks because of the lack of technological interoperability. If patched networks are initially constructed, it is very costly to rebuild the infrastructure.

1.2. Financing Means through Public Capital

Improvements and expansions of infrastructure can not be realized without adequate financial resources. Due to the need for long term investments of huge sums of capital, traditionally, governments have carried this burden.

In developing economies, public investment resources usually come from either foreign assistance, or reinvestment of revenue. Before the 1990s, government agencies owned and operated public telecommunications networks in the developing economies. Usually these state-operated organizations have been able to enjoy monopolistic revenue. However, profits of state-operated organizations have often been incorporated into national budgets and distributed to other non-profitable sectors outside of telecommunications.

Even if telecom organizations could freely reinvest their profits, the revenues would be insufficient to meet the financial needs for infrastructure development. Therefore, external capital funds should be used to finance the development of telecom infrastructure. There are two ways to finance telecom infrastructure development as capital providers. The first way is sovereign borrowings and other forms of direct government involvement. The second way is the endowment of private capital by various means.

Public financial resources were the major external financial resources used to develop telecom infrastructure until the late-1980s. In developing economies, public investment resources are usually foreign assistance, either multilateral or bilateral. However, the possibility of the telecom sector's access to public capital is likely to decrease gradually.

As for multilateral assistance, for example, it is not easy for the telecom sector to receive finance from the World Bank.

The World Bank will provide less project assistance except to the least developed economies. Therefore, telecom organizations in the rapidly developing Asian economies will not be able to qualify for project assistance from multilateral lending institutions because the telecom sector has good profit performance.

In developing economies there is a tendency to avoid the multilateral assistance, if financing from other funds is available. One major reason is the length of lead time to start the project. It usually takes 3-5 years for multilateral assistance to complete a project from beginning with a project finding to actual provision of services. The other reason is that most of the multilateral assistance is supplied with conditionalities that are hard to implement without painful reform.

As for bilateral assistance, it also becomes increasingly difficult for the telecom sector to receive ODA from developed countries. Donor countries usually regard the telecom sector as profitable compared to other infrastructure sectors. Restrictions on tied-assistance can be another reason for decreasing of Official Development Assistance (ODA). Such restrictions will reduce the telecom sector assistance.

1.3 Financing Means through Private Capital

Developing economies regard private financial resources as crucial factor for development of the telecom sector. The influx of private capital makes more rapid development of telecom infrastructure possible. The sources of private capital are sales, concessions, and market entry.

The sale of state-owned stock or assets creates a (fully or partially) privatized telecom corporation. The sale is included in the process of the privatization. The sale process takes mainly two forms. One process is the sale of shares to the public or to strategic investors through a bidding process. Another process may involve setting up a state-private consortium or a private consortium to undertake stock or assets.

Developed countries and developing Asian economies tend to prefer the former process to privatize their state-owned telecom organization. Latin American countries tend to prefer the consortium processes.

Concessions between monopolistic telecom organizations and private companies is the most popular means to bring private capital in the telecom market where laws and regulations have protected telecom monopolies.

The Build-Transfer-Operate (BTO) and the Build-Operate-Transfer (BOT) are two kinds of widely known concessions. In the BTO concessions, a part of the national infrastructure is built by private contractors. Then the system is transferred to the licensed corporations (or the government) and is operated by the licensed corporations or by the contractors in revenue sharing form. In the BOT concessions, a part of national infrastructure is built by private contractors. Then the system is operated by the contractor. The system is transferred to licensed corporations (or the government) as the contract expires.

Subject to restrictions on foreign investment, foreign corporations could participate effectively in these concessions. Developing economies need to transfer the capital and experiences from the developed countries. Developed countries' telecom carriers seek investment opportunities in other countries for diversification of their business. The concession can fulfill both needs.

The market entry of private corporations is the most radical means to encourage private capital into the telecom sector. In this model, new private corporations compete with former state-operated corporations in the sector. Most telecom administrations control competition by adjusting the number of competitor in the market, conditions for network connection, limits on investment into other businesses, and so on.

2. Malaysian Experience

2.1 Privatization in Malaysia

In Malaysia, a national privatization policy was first announced in 1983. Before privatization was adopted, the Malaysian economy was a heavily regulated like central planning economy.

The New Economic Policy (NEP) characterized privatization in Malaysia. NEP was adopted in 1971 to eradicate poverty in the nation, and to reduce racial economic disparities. It was intended to improve the economic status of the Malays called "Bumiputera".

The NEP has been a key of government socio-economical policy with increases in spending on basic services and education.

Since the introduction of the NEP, the public sector share of total expenditure has risen. That reads to growth of the workforces in the public sector. In the case of Jabatan Telekom Malaysia (JTM), a state-operated telecom carrier, there were about 8,000 workers at the end of the 1960s, rapidly increasing to over 21,000 during the 1970s(Kennedy 1995 p.220)

The Malaysian government had to implement privatization within the context of the NEP(EPU 1985). The privatization program planned to increase Bumiputera participation in the private corporate sector. The economic restructuring program that included privatization of the public organizations has sharply cut public sector expenditure.

2.2 Privatization and Competition in the Telecom Sector

The NEP led not only the expansion of JTM but also the increase in demand for telecom services with economic growth. JTM was not able to supply telecom services to effectively meet demand. The Ministry of Energy, Telecommunications and Posts (METP) was interested in privatization of JTM in 1982(Kennedy 1995 p.228). Privatization feasibility studies were conducted in 1984-1985.

The Telecommunications Service Act of 1985 provided for the transfer of telecom operating assets and liabilities from JTM to Syarikat Telekom Malaysia (TM) under the authority of the Minister of Finance. JTM was incorporated on 12 October 1984 as a fully government owned public limited company. The entire legal and administrative process was completed by 31 December 1986. On 1 January 1987, the incorporation phase of privatization was implemented. Almost all JTM employees (28,364) officially joined the staff of TM, while 102 employees were transferred to the new regulatory authority, which retained the JTM name (Daud 1989 p.119).

Responding to performance improvements, the Malaysian government proceeded with the partial share issue process of the TM. In September 1990, TM published a prospectus for the sale of 25 percent of its stock. The shares were listed in November 1990. Despite the Gulf War and a nervous equity market, on the first day of listing TM's shares, they were priced 20 percent above the offering prices (Syed Hussein Mohamed1994).

Privatization removed the administrative and financial burdens from the government particularly in terms of personal and financial obligation. Privatization also brought windfalls to the government through sold assets and shares to the private sector. Privatization brought 1,180 million dollars to the government from the private sector(EPU 1991 p.10).

The Malaysian government mandated that the privatized TM would compete with new telecom service providers. The private sector was aware that the telecom sector had profitability potential. The NEP stimulated the establishment of private telecom-related companies through preferences awarded to Bumiputera companies. Subject to the constrains of the NEP, foreign participation was welcomed in Malaysia. The government allowed a 30 percent foreign investment into the telecom sector.

The Malaysian government stated that "Apart from deregulation, the government will allow the maximum practical degree of competition in privatized industries (EPU 1991 p.17)." In this policy line, the government issued licenses to enter all telecom service markets after the privatization of TM. The Malaysian government decided to open the basic telephone service market to competition because TM had shown good managerial and financial performances. The Malaysian government issued 4 licenses for basic networks and services, 3 licenses for international gateways and services, 4 licenses for cellular services, and 3 licenses for Personal Communication Network services at the end of 1994.

2.3 Evaluation of Malaysian Reforms

Privatization and competition stimulated an increasing number of subscribers and enhanced networks. TM grew by 200-400 thousand lines every year. This performance can be explained as preparation for a competitive market structure by TM.

However, TM is actually the only provider of domestic and international fixed line telephone services. Other licensed companies have been preparing for their services. The biggest cellular telephone service provider, Cellular Communications Network Malaysia (Celcom), complained of high access charges for connecting with TM networks. It is very difficult to compete with the successor of the state-owned telecom carrier. TM predicts the telecom market in near future will be as follows: "the government has sought to minimize the duplication of infrastructure, and hence its policy has been managed and orderly competition in the telecom sector (Telekom Malaysia 1994 p.64)." The competition in Malaysia can be regarded as limited competition managed by the government.

In the mobile telecom sector, the competition is very effective for development of the network. There are 28 radio paging service providers and 4 cellular telephone service providers. According to these providers, 3 Personal Communications Service providers have been granted new licenses and are preparing for the operation. Celcom is the prime service provider with 40 thousand subscribers at the end of 1994. Private companies show the will to invest into the mobile telecom sector which provides for business opportunities without requiring huge amount of capital like fixed line telecom.

Competition is improving the mobile communications in Malaysia by a rapid pace because corroboration between JTM, TM, and other private telecom service provider is successful. The government plans to raise the telephone penetration rate to 40 lines per 100 persons by 2020.

Privatization and competition made financing for network development easier. Telecom companies were able to mobilize domestic capital from the Malaysian economic growth after the late 1980s. Privatization by issuing shares could draw capital from the private sector and especially promote investment from the small shareholders. The broadening nationwide capital accumulation stimulated the Malaysian capital market and removed fiscal burden from the government.

However, there are two problems in the competitive telecom policy in Malaysia. The first problem is the access charge for connecting with TM networks. This problem was made apparent by Celcom. If access charges are set inappropriately, competition will not work effectively. The second problem is dual investment for telecom infrastructure. If private corporations concentrate investments on the profitable areas, expansion of telecom networks in the rural and remote areas will be dilatory.

3. Thai Experience

3.1 Public-Corporatization in Thailand

The government of Thailand has also corporatized its telecom operations. Telephone Organization of Thailand (TOT), the public corporation providing domestic telephone service, was established and began operation in 1957. In 1974 the government established Communications Authority of Thailand (CAT) as a public corporation providing postal services, international telephone services except to and from Laos and peninsula Malaysia, and telegram services. TOT and CAT are operated under the Ministry of Transport and Communications (MOTC).

Private sector investment into telecommunications services is restricted without concessions with two public corporations. The laws and regulations are assigning absolute monopolistic status for providing public telecom services to TOT and CAT.

The scope of operation by TOT and CAT in some areas can not be delimited clearly. Basic telecommunication acts are too old to regulate new services in the telecom sector, like case of cellular service provider. The flexible application of legislation brought the development of the cellular services, but it makes telecom policy confusing.

Private companies planned to enter the telecom sector in the late 1980s. Thai people showed a strong demand for telecom services and required improvements of the telecom service supply. They blamed the inefficiency on the national telecom networks.

The government decided to allow the private sector to enter the telecom service markets by concessions. CAT gave concessions of radio paging to the joint venture of the Shinawatra Group and Pacific Telesis in June 1986(Suehiro 1995). After this case, TOT and CAT made many concessions, mainly in the radio communications sector. Concessions are the only means to accelerate telecom infrastructure development by the private sector without amending acts which authorize a monopoly.

3.2 BTO Concessions

A shortage of resources and capital limited the telecom infrastructure expansion in Thailand. "The inability to meet the rising telephone demand basically stems from the lack of sufficient internal resources on the one hand, and the imposition by the Ministry of Finance for a maximum foreign loan ceiling of 1.5 billion US dollars on the other (Chatri 1992)."

While the endowment of private capital by concessions had become popular, basic telephone service did not use concessions with private corporations before 1989. The main reasons to avoid concessions were related to national security and the scale of economy.

However, it became clear that TOT could not achieve their goal of telephone line installation that had been set by the seventh National Social-Economic Development Plan (1992-96). TOT had to install 4.1 million lines before the end of 1998. TOT has only installed 100 thousand lines per year. The shortage of physical resources and lack of experience in managing big installation projects were the main reasons to use concession for fixed telephone network development rather than the lack of capital.

In 1991 the Thai Cabinet, within the boundaries imposed by the existing acts and regulations, invited the private sector to participate in the fixed line telephone sector on a Build-Transfer-Operate (BTO) concession basis.

TOT auctioned a bid 2 million lines Metro-Bangkok area concession and 1 million lines rural area concession. The Charoen Pokphand (CP) Group tried to tender by forming a joint venture, Telecom Asia (TA), with NYNEX. TOT awarded a concession to TA for the Metro-Bangkok area in August 1991. The rural area

BTO concession was awarded to Thai Telephone and Telecommunications (TT&T) in July 1992. TT&T is a consortium that is composed of Jasmine International, Loxely, Ital-Thai, Patra Thanakit and Nippon Telegraph and Telephone (NTT). MOTC requested the participation of foreign telecom carriers to the joint venture for introduction of technical and financial supports.

3.3 Evaluation of Thai Reforms

BTO concessions stimulate telecom infrastructure development by creating a competitive situation. TA and TT&T transferred their building facilities to TOT when they set up the network. TA and TT&T participate in the operation of build-transferred facilities under the TOT ownership. TT&T will be able to complete the installation of a total of 1 million lines before the end of the concessions installation period. Private constructors want to show their ability to operate telecom installation projects for tendering the next 6 million lines BTO concession that is being planed by the eighth National Social-Economic Development Plan.

Private telecom companies finance their projects in many ways, including credits from the private financial sector, initial public offering (IPO) and selling of shares, capital from foreign partners, and others. These behaviors stimulate not only the telecom sector but also the financial market in Thailand. The impressive performances of BTO contractors relaxed the financial market for private telecom-related corporations.

For example, TT&T has used credits and shares. TT&T signed credit facilities that consisted of term loan and Suppliers Credit in November 1993. TT&T completed 50 million shares of IPO in April and listed on the Stock Exchange of Thailand in May 1994. Credits were estimated at 1 billion US dollars, and IPO obtained 290 million US dollars. State enterprises and public corporations can not use flexible financial means as far private companies. Telecom-related companies have rushed to make IPOs. In 1994, 6 telecom- related companies made IPOs and they acquired a total of 893.6 million US dollars The telecom sector had a 39.1 percent share of the IPO market in 1994. The stocks of telecom related corporations boomed at the Bangkok Stock Exchange that year.

BTO and other concession styles are suitable means for endowment of the foreign and domestic private capital, but concessions have to be concluded prudently. Two problems of concessions are the inclusion of the rural areas and the terms of the concessions.

First, BTO projects would not be effective for improving telecommunications in the rural areas. Private corporations do not prefer to enter markets with low profitability. Only 30 percent of the rural villages had been connected by telephone networks in Thailand. TOT adopted Very Small Aperture Terminal (VSAT) technology to improve the situation. This project is mainly financed by public capital. The rural area BTO concession aims to install telephone lines in local cities that have the need for telecom services.

Secondly, for effective BTO projects, contractors have to consider the terms of the concessions prudently. Concessions may continue for many years, for example, 25 years in the Thai case. The most controversial terms are the rates of services for the customers. Rates of public services affect broad areas of the national economy. If the terms of the concession include to raise the rate of services after building new facilities, people, especially of the low income bracket, would be opposed to the raise rate increase. In the Bangkok Highway case, the concession confused many dues to the toll.

4. Japanese Experience

4.1 Financial Means Used By NTTPC

Nippon Telegraph and Telephone Public Corp. (NTTPC) was privatized in 1985 and became Nippon Telegraph and Telephone Corp. (NTT). NTTPC installed about 40 million lines from 1953 to 1984. From the mid-1960s, expenditures for construction increased every year to catch up with the demand for telephony and a complete nationwide automatic exchange system.

The financial resources used for investing in networks could be divided into internal funds raised within NTTPC and external funds raised outside NTTPC. Internal funds included operating income as well as depreciation and a reserve for amortization of discounted bonds, both of which were appropriated for operating expenses. External funds included telegraph and telephone bonds, installation charges and government loans.

External funds provided a large amount of the financial resources to NTTPC's telecom projects. The ratio of internal funds exceeded that of external funds until 1965. The share of external funds increased throughout the 1960s and reached its peak in 1975 (fiscal year). In 1975, NTTPC financed 70.6 percent of their total funds by externally (NTTPC 1984).

4.2 Telegraph and Telephone Bonds

Telegraph and telephone bonds were the main resources of external funds. Telegraph and telephone bonds could be classified into 4 main groups. These are; Beneficiary Bonds, Government Bonds (Government-Guaranteed Bonds and Government-Undertaken Bonds), Special Bonds (Special Public Subscription Bonds and

Special Non-public Bonds), and Foreign Currency Bonds.

Beneficiary Bonds are the main means of finance for improvements through the 1960s and the 1970s.

Beneficiary Bonds are unique in that they financed the installation and development of telecom infrastructures. Beneficiary Bonds have been explained as "bonds accepted by subscribers" or "bonds issued to subscribers". The reason for that explanation comes from the basic concept of that bond. Beneficiary Bonds reflected the thought that those who would benefit ought to bear the cost of installing telecom facilities. From the beginning of the Japanese telecom industry, this thought had existed in the form of a grant for the telecom organization by the person who wanted to install the telephone.

After World War II, subscribers had to pay the Burden Charge for Telephone Facilities to install telephone lines. However, it was impossible to finance the growing telephone demands. To alleviate the shortage of financial resources, NTTPC combined the installation of subscriber telephone lines with Beneficiary Bonds. In other words, a person who wanted to install telephone lines was obligated to purchase Beneficiary Bonds.

The legislative basis for Beneficiary Bonds could be found in the "Law of Nippon Telegram and Telephone Public Corporation 1952 (NTTPC Law)", "Law Concerning Temporary Means for Sharing Telephone Facilities' Cost 1951 (Sharing Law)", and "Law Concerning Provisional Measures for Expanding Telecom Facilities of 1960 (Expanding Law)". NTTPC Law ruled that NTTPC could raise the funds by long-term liability, short-term liability, and telegram and telephone bonds with approval of the Minister of Posts and Telecommunications. The amount of liabilities and bonds was subject to the decision of Diet. The Sharing Law and Expanding Law stated the legal obligation to purchase the Beneficiary Bonds for new subscribers.

The Sharing Law was established to collect a part of the installation cost from new subscribers. The law was amended to undertake the Beneficiary Bonds by new subscribers in January 1953. The law was abolished on March 31,1961. However, in the beginning of the 1960s, installation of telephone subscriber lines fell short of the demand. Japanese economic growth increased the telephony demand rapidly during the 1960s-70s. The Expanding Law aimed to improve the financial situation of NTTPC and to replace the Sharing Law for installing much more subscriber line. The Expanding Law was abolished on 31 March 1983 because the system was in place for meeting the telephony demand.

Article 2 of the Expanding Law stated that when NTTPC accepted applications for the installation of subscriber telephones, the applicant should purchase bonds. The amount of Beneficiary Bonds purchased by the applicant was classified according to the scale of telephone interexchange office that the new subscriber line had connected. The maximum amount paid for bonds were within 150 thousand yen in Tokyo and Osaka area, and the minimum amount was more than 20 thousand yen in underpopulated areas. The redemption term of bonds was 10 years. The interests on the bonds were temporarily set by the Minister of Posts and Telecommunications to avoid the fluctuation of the Japanese financial market. For example, the interest on bonds issued in 1963 was 4 percent, and the interest on bonds issued in December 1974 was 8.8 percent.

4.3 Evaluation Of Public Bond Issue

There are three factors needed for NTTPC's bonds to mobilize private capital well. These are; 1) existence of the bond market, 2) appropriate redemption plans, and 3) regulative supports.

Loan floatation markets and secondary markets were needed to issue telegraph and telephone bonds, except Government-Undertaken Bonds and Special Non-public Bonds. NTTPC strove to establish secondary markets for Beneficiary Bonds. When secondary markets had not been established, Beneficiary Bonds were sold at discount rate by subscribers who perceived bonds as the cost for installation. The bonds' affordability was a crucial factor for the Beneficiary Bonds issuance. NTTPC calculated the appropriate amount of bonds to be undertaken by subscribers and considered the income gaps between urban and rural areas.

In other words, Beneficiary Bonds were borrowings from subscribers. NTTPC had to make appropriate redemption plans for sustainable bonds issues. Suspension of redemption for the Beneficiary Bonds not only caused NTTPC's financial crisis but also effected all public financial markets. The first reason was that, the Beneficiary Bonds encompassed a large amount of capital. In the first half of the 1970s, the Beneficiary Bonds amounted to more than 400 billion yen a year. The second reason was that, Japanese people did not give credit to the public bonds, if the redemption of the Beneficiary Bonds collapsed.

Legislative support was a crucial factor to successfully gain financing by the Beneficiary Bonds. Recent telecom policy trends request liberalization of the sector, such as privatization and a competitive market structure. Under these conditions, it is very difficult to support specific organization. However, as the United States is considering the Universal Service Fund, some regulative instruments ought to make preparations for the improvement of the telecom infrastructures. A revised Beneficiary Bonds system will provide financial means for developing economies, especially the countries that have state-owned telecom organizations.

5.Conclusions

State-owned telecom organizations ought to be privatized. At least, state-operated telecom organizations should be managed by business principals to reduce structural inefficiencies. Public-corporatization is the first step for reform of the telecom sector. Privatization processes in developing economies should proceed deliberately. In Malaysia and Japan, each country public-corporatized their state-operated telecom organizations before share issuing. Thailand also public-corporatized telecom organizations and has been considering further steps for privatization.

The government ought to retain the authority in order to have a great leverage over activities of the former monopoly to make a stable development possible. Until certain telephone penetration rates are achieved, regulative functions of the administrations are critical for the creation of competitive telecom markets.

It would be premature to let the private sector compete with former monopolies in developing economies. In Malaysia, Celcom have complained of high access charge rate for connecting with networks of TM. Even in Japan, New Common Carriers that provide long distance services have protested against high access charge rate for connecting with networks of NTT.

When we consider the introduction of competition into the public sector, the important point is that private capital contributions prefer to invest only where profit is likely. The priority in the developing economies is to increase telephone penetration rates on a national level. The government must not leave rural area in the present state. If the telecom services are supplied with a large gap between the city and rural areas, the government can not find the solutions for problems of urbanization. Development of the telecom infrastructure can contribute to improvements of the education, the medicine, and the environment.

We recognize the significance of competition in telecom markets. It is important to let private corporations compete with each other, like the early installation cases in Thailand. However, it is difficult to realize a competitive telecom market without careful guidance in the developing economies. It is more realistic to adopt a limited competitive policy rather than completely rely upon competition. For example, the administrator can allow competition in specific markets or areas. There is a difference of means for mobile telecom sector development between Malaysia and Thailand. However, the mobile sector has been growing up rapidly in both countries. This fact shows the possibility of competition in mobile telecom markets. On the other hand, when private companies would compete in the market, the administrator should design consistent national networks.

The potential of the telecom sector's access to public capital flows tends to decrease gradually. Moreover, the private sector is eager to invest in the telecom sector.

The participation of the private sector will accelerate development of telecom networks, like Malaysia and Thailand. There are various means for encouraging private sector resources. Each government should select suitable ways that would match the telecom sector development condition with national economic plans and regulations.

When an administration approves the monopolistic status of the state-owned organizations, concessions are an effective way to encourage private corporations to participate in the telecom sector reform. The government and the contractors have to discuss terms of concessions deliberately, since concessions usually last considerably long, 25 years in the Thai cases.

Trends in Thai stock market show the existence of a financial market for telecom business. In developing Asian economies, the middle-income class can afford to undertake bonds, like Beneficiary Bonds by the NTTPC. Bond issues can be considered as another alternative for endowment of private capital. The thought that those who would benefit ought to bear the cost of installing telecom facilities is effectable for the endowment of small private capital. However, before public bond issues are implemented, the administrator must formulate appropriate policies. Research for the affordability of bonds among the low-income class would be needed before it is implemented. In addition, controlling appropriate redemption plans is crucial for successful bond issues in developing economies. A collapse of the redemption would cause financial crisises that would damage the national economy.

References

Chatri Sripaipan, Sumeth Vongpanitlerd (1992)
"The Thailand Case", Transnational Data and Communications Report, pp.30-36, July/August 1992,

Daud. Isahak.(1989)
"Meeting the Challenges of Privatization in Malaysia", Restructuring and Managing the Telecommunications Sector, pp.118-121 Wellenius, B., Stern,P., Nulty, T., and Stern, R.(eds.), World Bank, USA

Economic Planning Unit Prime Minister's Department (EPU) (1985)
Guidelines on Privatization, Government Printing Office, Malaysia

Economic Planning Unit Prime Minister's Department (EPU) (1991)
Privatization masterplan, Government Printing Office, Malaysia
Jomo, K.S. (eds.) (1995)
Privatizing Malaysia., Westview Press, USA
Kennedy, Laurel.(1995)
"Telecommunications" Privatizing Malaysia, pp.219-235, Jomo, K.S.(ed.), Westview Press, USA
Ministry of Energy, Telecoms and posts, Malaysia
Telecommunications in Malaysia Towards Vision 2020, Government Printing Office, Malaysia
Nippon Telegraph and Telephone Public Corporation (NTTPC) (1970-1984)
Annual Report, each year, Nippon Telegraph and Telephone Public Corp., Japan
Nippon Telegraph and Telephone Public Corporation (NTTPC), Accounts and Finance Bureau (1984)
Kanyusya saiken no kiroku, Hifumi Syobo, Japan
Suehiro, Akira. (1995)
"Sinawatra Group - Tai no jyoho tsushin sangyou to sinnkou zaibatu " Monthly Journal of Institute of Development Economics Vol.36 No.3, Institute of Development Economics, Japan
Syed Hussein Mohamed(1994)
"Corporatization and Partial Privatization of Telecommunications in Malaysia", Implementing Reforms in the Telecommunications Sector, Wellenius, Bjorn. and Stern, Peter A. (eds.), World Bank, USA
Telekom Malaysia Berhad (1994)
Telekom Malaysia Berhad 4% Convertive Bonds Due 2004 (Panfret), Telekom Malaysia, Malaysia
Lofstorm, Mark D. and Wedemeyer, Dan J. (eds.) (1994)
Pacific Telecommunications Council 14th Annual Conference Proceedings, Pacific Telecommunications Council, USA
Wellenius, Bjorn.(1993)
Telecommunications: World Bank Experience and Strategy, USA
Wellenius, Bjorn. and Stern, Peter A. (eds.)(1994)
Implementing Reforms in the Telecommunications Sector, World Bank, USA
World Bank(1994)
World Development Report 1994, Oxford university Press, USA

Pacific Telecommunications Council
2454 South Beretania Street, Suite 302
Honolulu, Hawaii 96826 USA
Telephone: 1.808.941.3789 Facsimile: 1.808. 944.4874
E-Mail: info@ptc.org

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